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ALKALI METALS BOILING AND CONDENSING INVESTIGATIONS

Quarterly Progress Report 12

Edited by

G. L. CONVERSE
and
F. E. TIPPETS

prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONTRACT NAS 3—2528

SPACE POWER AND PROPULSION SECTION

MISSILE AND SPACE DIVISION

GENERAL ELECTRIC

CINCINNATI, OHIO 45215

ALKALI METALS BOILING AND CONDENSING INVESTIGATIONS
QUARTERLY PROGRESS REPORT 12

Covering the Period
April 1, 1965 through June 30, 1965

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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July 23, 1965

SPACE POWER AND PROPULSION SECTION
MISSILE AND SPACE DIVISION
GENERAL ELECTRIC COMPANY
CINCINNATI, OHIO 45215

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FOREWORD

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NOMENCLATURE

The symbols and units listed below are used in all derivations. The symbols listed below are occasionally used with other units in the figures, tables, or in the written text. Whenever this is done, the appropriate units are indicated.

Simple Latin Letter Symbols

Symbol	Quantity	Units
A	Area	ft^2
a	Radial acceleration ($a = g/g_c$)	Dimensionless
b	Bubble height	ft
D	Diameter	ft
E	Mass fraction of liquid entrained in the vapor core	Dimensionless
f	Darcy-Weisback friction factor	Dimensionless
G	Mass velocity (flow rate per unit flow area)	$lb_m/hr\text{-}ft^2$
g	Acceleration due to gravity	4.17×10^8 ft/hr^2
h	Heat transfer coefficient	$Btu/hr\text{-}ft^2\text{-}°R$
J	Conversion factor (mechanical equivalent of heat)	778 $ft\text{-}lb_f/Btu$
K	Thermal conductivity	$Btu/hr\text{-}ft$ $°R$
k	Slip ratio ($k = V_g/V_f$)	Dimensionless
L	Length	ft
M	Molecular weight	lb_m/lb_m mole
P	Pressure	lb_f/ft^2
Q	Rate of heat flow	Btu/hr
R	Universal gas constant	$1545\dfrac{ft\ lb_f}{lb_m\ mole\ °R}$
r	Radius	ft
s	Arc length	ft
T	Temperature	$°R$
t	Time	hr
U	Overall heat transfer coefficient	$Btu/hr\text{-}ft^2$ $°R$
V	Velocity	ft/hr

Symbol	Quantity	Units
W	Flow rate	lb_m/hr
X	Flowing quality ($X = W_g/W$)	Dimensionless
Z	Axial coordinate of the boiler	ft

Composite Latin Letter Symbols

Symbol	Quantity	Units
A_F	Flow area	ft^2
A_2/A_1	Area ratio in a sudden expansion	Dimensionless
C_p	Constant pressure specific heat	$Btu/lb_m \; ^oR$
D_T	Inside tube diameter	ft
g_c	Conversion factor	$4.17 \times 10^8 \; \dfrac{ft \; lb_m}{lb_f \; hr^2}$
h_c	Condensing heat transfer coefficient	$Btu/hr\text{-}ft^2 \; ^oR$
h_f	Liquid enthalpy	Btu/lb_m
h_{fg}	Latent heat	Btu/lb_m
h_g	Vapor enthalpy	Btu/lb_m
K_E	Irreversible loss coefficient due to sudden expansion	Dimensionless
N_{Nu}	Nusselt number ($N_{Nu} = h \; D/K$)	Dimensionless
N_{Pe}	Peclet number ($N_{Pe} = G \; D \; C_p/K$)	Dimensionless
N_{Pr}	Prandtl number ($N_{Pr} = \mu \; C_p/K$)	Dimensionless
N_{Re}	Reynolds number ($N_{Re} = \rho \; V \; D/\mu$)	Dimensionless
P_W	Wetted perimeter	ft
$P_{(X)}$	Probable error in X	Dimensionless
q''	Heat flux	$Btu/hr\text{-}ft^2$
q''_c	Critical heat flux	$Btu/hr\text{-}ft^2$
r_c	Cavity-mouth radius	ft

Composite Latin Letter Symbols (Continued)

Symbol	Quantity	Units
R_g	Void fraction	Dimensionless
v_{fg}	Specific volume change in going from liquid to vapor	ft^3/lb_m
X_c	Quality at the critical heat flux	Dimensionless

Simple Greek Letter Symbols

Symbol	Quantity	Units
β	Bubble contact angle	radians
Γ	Mass flow rate of liquid per unit circumference $\left[\Gamma = \frac{(1-X)\,W}{\pi\,D} \right]$	$lb_m/hr\text{-}ft$
Δ	Finite difference	Dimensionless
Δ	Thickness of the tape wound around the centerbody of the helix	ft
δ	Film thickness	ft
θ	Angular displacement	radians
μ	Dynamic viscosity	$lb_m/hr\text{-}ft$
ν	Kinematic viscosity	ft^2/hr
ρ	Mass density	lb_m/ft^3
σ	Surface tension	lb_f/ft
$\mathcal{T}$	Vapor shear stress	lb_f/ft^2

Composite Greek Letter Symbols

Symbol	Quantity	Units
σ_c	Condensation coefficient	Dimensionless
σ_e	Evaporation coefficient	Dimensionless
$\mathcal{T}*$	Dimensionless Shear Stress	Dimensionless

Subscripts

Symbol	Quantity
a	Axial velocity component
b	Bulk fluid temperature
c	Value at the critical heat flux condition
cb	Diameter of helix centerbody or probe
DNB	Departure from nucleate boiling
e	Equivalent value of a given quantity for application to helical flow
f	Indicates a liquid phase property
FB	Film boiling
FE	Film evaporation
g	Indicates a vapor phase property
H	Value referred to helix
I, i	Inside or inlet
K	Potassium
l	Refers to liquid phase
M	Maximum
Na	Sodium
NB	Nucleate boiling
o	Outlet or outside
PB	Pool boiling
s, sat	Saturation
SH	Superheat
SHV	Superheated vapor
T	Tangential
TB	Transition boiling
TP	Two-phase
TPF	Two-phase friction
v	Refers to vapor phase
w	Value at the tube wall

I SUMMARY
F.E. Tippets

This program is being conducted for the National Aeronautics and Space Administration under Contract NAS 3-2528 to obtain two-phase heat transfer and fluid flow data for potassium under conditions of boiling and condensing approximating those anticipated in large space turbo-electric power systems. Test equipment development, materials studies and theoretical analysis related to the experimental work are conducted as a support effort. The following items summarize the work performed during the quarter ending June 30, 1965.

300 KW Project

All boiling test data obtained with the 300 KW Facility have been reduced and reported. These data are now being analyzed and treated in preparation for a topical report covering this project.

Water pressure drop tests to obtain single-phase friction factors for the insert and non-insert test section geometries, as an aid to correlating the two-phase potassium pressure drop data obtained, have been completed and the results are reported in Section II.

Critical heat flux conditions and transition boiling heat transfer coefficients have been calculated from the data obtained with the 3/4-inch nominal diameter test section, both with and without a helical insert. These results and the analytical treatment used to derive them are presented in Section II.

The principal work under this project over the next quarter will be completion of the analytical effort and preparation of the

topical report for the project.

100 KW Project

Test Set No. 3, done with a 3/8-inch nominal diameter
(0.42-inch I.D.) plain tube test section (no insert) were
completed in early April. In addition to nucleate boiling heat
transfer coefficient measurements and some boiling inception tests,
several critical heat flux determinations were made at heat flux
levels to 225,000 Btu/hr-ft^2 and heat transfer coefficient data
beyond the critical heat flux point at 2100°F saturation temperature
in the stable film boiling and superheated vapor regimes up to
200°F vapor superheat were obtained. All the heat transfer data
of Test Set No. 3 have been reduced and the results are presented
in Section III.

Test section No. 4, a 3/4-inch nominal diameter tube
(0.74-inch I.D.) containing an insert composed of a smooth plug
at the inlet followed by a helix of pitch-to-diameter ratio equal
to two (P/D = 2) with internal thermocouples for fluid temperature
distribution measurements, was installed and tests were started in
early May.

Test Set No. 4 was completed June 10, including critical heat
flux determinations and measurements of nucleate boiling, film
boiling and superheated vapor heat transfer coefficients at both
1800°F and 2100°F saturation temperature. In addition, boiling
inception tests were performed, with special emphasis on measuring
conditions in the vicinity of the boiling boundary located at the
inlet-plug insert; and some adiabatic two-phase pressure drop data
was obtained at 1900°F using the insert thermocouples to measure
local saturation temperature for deduction of local fluid pressure.

The data from Test Set No. 4 is being reduced and will be reported in the next Quarterly Progress Report.

After completion of Test Set No. 4, Test Section No. 5 was installed and testing began early in July. Test Section No. 5 is a 3/4-inch nominal diameter tube (0.74-inch I.D.) containing a wire-wrapped inlet plug insert in combination with a continuous helical wire coil insert (P/D = 2) together with internal thermocouples. Included as part of Test Section No. 5 is a radiant-heated artificial nucleator of the "hot-finger" type, located at the test section inlet, for additional boiling inception tests.

It is expected that Test Set No. 5 will be completed during the first half of August. Following this, the main work of this project will then be analysis and treatment of the data obtained and preparation of the topical report covering the project.

50 KW Project

All of the five sets of condensing test data obtained with the 50 KW Facility have been reduced and reported. These data are now being analyzed and treated further in preparation for a topical report covering this project. Some additional treatment of the data taken with a tapered plug insert in the 5/8-inch I.D. test section (Test Set No. 2) and the data taken with the 3/8-inch I.D. plain tube test section (Test Set No. 3) was required in order to correct for error in fluid temperature measurement at the test section inlet. These data have been corrected for this error and are presented herein.

An analysis of the vapor-phase thermal resistance in condensing is given in Section IV. The analysis proceeds on the basis of

kinetic gas theory to derive the vapor-phase condensing heat transfer coefficient, which is then used for comparison with the data.

A discussion of the results obtained during a test with Test Section No. 5 to stabilize the liquid-vapor interface in the active condensing section (5/8-inch I.D. tube with instrumented tubular insert) is given in Section IV.

Over the next quarter the principal work under this project will be completion of the analytical effort and preparation of the topical report on the project.

Facilities, Instrumentation and Materials Support

Accountings of supporting work conducted throughout the quarter in the areas of facility maintenance and equipment changes, instrumentation, and materials are given in Sections V and VI. This work was concerned with operation of the 100 KW Facility, including test section fabrication. The fabrication of Test Sections No. 4 and No. 5 are described in detail in Section VI.

Analysis

Analytical treatment of nucleate boiling heat transfer is given in Section VII, including theoretical prediction of nucleate boiling heat transfer coefficients, analysis of the relationship between cavity size on the heat transfer surface and the wall superheat required to initiate bubble nucleation in potassium, comparison of theoretical predictions with data from the 100 KW Facility, and recommendation of design procedure for calculating nucleate boiling heat transfer coefficients.

300 KW Facility Modification and Test Condenser Design

Contract Modification No. 10, dated 6-18-65, adds two engineering design tasks to the program, covering:

a) Design of a modification of the 300 KW Facility to test multiple-tube, NaK-cooled condensers at power levels to 300 KW, including addition of a tertiary loop and a 300 KW multiple-tube facility boiler.

b) Design of two multiple-tube condensers for use in the modified 300 KW Facility.

This new work has been started and the bulk of it will be carried out over the next Quarter.

II 300 KW PROJECT
JR Peterson/DR Ferguson

The 300 KW Facility is used to obtain potassium boiling
heat transfer data. The boiling test section is a controlled
temperature type, i.e., it is a two-fluid heat exchanger with
the temperatures of the heat transfer fluids rather than the
surface heat flux being controlled. Reference 1 presents a
detailed description of the facility.

Status of Loop and Test Section

Tests in the 300 KW Facility were completed on schedule
in November 1964. The facility is in good order, awaiting
firming of plans for further tests.

Status of Data Reduction

All data obtained with the 300 KW Facility have been
initially reduced, corrected and reported. Some of the early
data obtained with the 1.0-inch nominal diameter boiler tubes,
however, were reduced before the NRL potassium thermodynamic
properties became available, and certain refinements to the
calculational procedures have been made since the initial reduc-
tion. Thus, the reduced data are being re-examined and recalculated
where necessary, to place all results on a common basis in prepara-
tion for the topical report on this project.

Single phase (water) pressure drop tests have been conducted
in support of the two-phase potassium pressure drop analysis task.
Data were taken in a 1.0-inch nominal diameter tube containing
helical inserts of pitch to diameter ratios (P/D)* of two and six,
and in a 3/4-inch nominal diameter tube both without an insert and

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*P/D = Number of pipe internal diameters per 360° revolution of
  helix.

with an insert of P/D = 6. These data are shown in Figure 1 as a
plot of friction factor versus superficial Reynolds number.
Also shown on the Figure is the empirical relationship for
smooth tubes,which shows good agreement with the experimental data
obtained without insert.

Status of Data Evaluation

     1. <u>Derivation of Helix Equations</u>:

          As a part of the analytical effort associated
with the data evaluation tasks certain parameters
associated with the helical inserts employed in the
tests, such as equivalent diameter, helical path
length, helical velocity and radial acceleration
have been derived. The expressions obtained as well
as the derivations employed are given in Appendix A
of this report.

     2. <u>Correlation of Single Phase Pressure Drop and Heat
Transfer With Inserts</u>:

          It is useful in the analysis and evaluation of
the boiling potassium heat transfer and pressure loss
data obtained from the 300 KW Project to compare the
two-phase results with the corresponding single-phase
values. In view of this requirement, methods for
prediction of the single phase pressure drop and gas
phase heat transfer coefficients in tubes containing
helical inserts were sought.

          Gambill (Reference 2) has assembled single-phase
heat transfer and pressure drop data for flow in tubes
containing twisted tapes, and has found that the
friction factors obtained under these conditions could

be correlated within approximately $\pm$ 20% by
employing the equivalent diameter and maximum
helical path length and velocity in the calcu-
lation of the friction factors and Reynold's
Numbers.

This procedure was employed in an attempt
to correlate the water pressure drop data pre-
sented in Figure 1 of this report for the flow of
water in tubes containing helical inserts. The
data obtained by Greene (Reference 3) with tubes
containing helical inserts were also treated.
No additional data for single-phase heat transfer
or pressure drop in tubes containing helical inserts
could be found in the literature.

Figure 2 shows the friction factor data of
Greene together with the SPPS data obtained under
this project. The data points are omitted in this
latter figure for ease of comparison. The smooth
curves shown represent the magnitude and range of
the experimental data. Figure 3 compares this data
with the prediction obtained by use of the maximum
helical velocities and lengths (V_{HM} and L_{HM}) together
with the equivalent diameter (D_e). The definitions
of these quantities, based upon the derivations given in
Appendix A, are given by the following equations along
with the equations for the equivalent friction factor
f_e and the equivalent Reynolds Number $(N_{Re})_e$.

$$V_{HM} = V_a \sqrt{1 + \left(\frac{\pi D_i}{P}\right)^2} \tag{1}$$

$$L_{HM} = L \sqrt{1 + \left(\frac{\pi D_i}{P}\right)^2} \tag{2}$$

$$D_e = \frac{D_i \left[1 - \left(\frac{D_{cb}}{D_i}\right)^2\right]}{1 + \frac{D_{cb}}{D_i} + \frac{1}{\pi}\left(1 - \frac{D_{cb}}{D_i}\right)} \tag{3}$$

$$f_e = \frac{\Delta P}{\frac{L_{HM}}{D_e} \frac{\rho_f V_{HM}^2}{2g_c}} \tag{4}$$

$$(N_{Re})_e = \frac{D_e V_{HM} \rho_f}{\mu_f} \tag{5}$$

It can be seen from Figure 3 that the single-phase pressure drop data are correlated to the empirical expression for smooth tubes quite well by the approach employed, with the exception of the data obtained by Greene for the very tight twist ratio P/D = 0.56. The recommended correlation, which is the smooth tube equation (Reference 4), is given below. It should be noted that the friction factors employed in Reference 4 are defined to be smaller by a factor of four than the friction factor utilized in Equation (6).

$$f_e = \frac{0.316}{(N_{Re})_e^{\frac{1}{4}}} \tag{6}$$

A plot of the ratio of experimental to predicted friction factors, employing equation (6), is shown in

Figure 4 , where the maximum, minimum and average ratios are given as a function of P/D. The analytical technique described is seen to be valid within approximately 20% in the range $1 < P/D < 6$. At P/D = 0.56 the friction factor is apparently over-estimated.

Greene also measured the single-phase heat transfer coefficient in his experiments with helical inserts. The data of Greene, (Reference 3), are plotted in Figure 5 as the swirl flow Nusselt Number (N_{Nu_i}) divided by the cube root of the Prandtl Number (N_{Pr}) versus the Reynolds Number (N_{Re_i}), the dimensionless groups being based upon the axial velocity V_a and the tube inside diameter D_i. The prediction of the Colburn equation (Reference 4) for smooth tubes is shown for comparison.

Figure 6 shows the correlation of heat transfer data by use of the maximum helical velocities and lengths (V_{HM} and L_{HM}) together with the equivalent diameter (D_e). Equations (1), (2), (3), and (5) were employed as in the correlation of the single phase pressure drop data, for V_{HM}, L_{HM}, and (N_{Re_e}) respectively. Equation (7), following, defines the equivalent Nusselt Number (N_{Nu_e}) that was used.

$$(N_{Nu_e}) = \frac{h\,D_e}{k} \qquad (7)$$

It can be seen from Figure 6 that the experimental heat transfer data correlate among themselves quite well with the approach employed, but the agreement with the smooth tube prediction is not as good as was obtained in the single-phase friction factor correlation. An empirical line, shown in Figure 6, was drawn through the correlated values. This line is recommended for the prediction of single-phase heat transfer coefficients in tubes containing helical inserts. The correlation is recommended for fluids having Prandtl Numbers within an order of magnitude of the water test data used in the derivation; that is, a Prandtl Number within an order of magnitude of 1.0. The correlation is not recommended for potassium liquid, but may be used for potassium vapor. The equation for the empirical single phase heat transfer correlation is given as follows:

$$(N_{Nu_e}) = 0.359 \ (N_{Re_e})^{0.563} \ (N_{Pr})^{1/3} \qquad (8)$$

The uncertainty in the vapor phase heat transfer coefficient computed for potassium from equation (8) is quite large, due to the limited number of measurements upon which the equation is based and due to the present uncertainty regarding the transport properties of potassium vapor.

3. Local Results

Procedures for the calculation of local heat transfer and pressure drop parameters from the 300 KW Facility boiling data, along with the results obtained from sample cases, were presented in Reference 7. These

results showed the local nucleate boiling heat
transfer resistance is small in comparison to the
primary fluid and boiler tube wall thermal resistances.
It is therefore less important to know the nucleate
boiling resistance accurately in once-through boiler
design than the critical heat flux and transition and
film boiling heat transfer coefficients.

Because of its relatively small magnitude, the
nucleate boiling resistance cannot be obtained accurately
in the two-fluid 300 KW test section, since the magnitude
of expected errors in the primary fluid and boiler tube
wall thermal resistance are of the same order as the
nucleate boiling resistance. For these reasons, analysis
and evaluation of the critical heat flux and of the
transition boiling coefficients have been emphasized and
less emphasis was placed on further treatment of the
nucleate boiling results.

Using the calculational procedures detailed in
Reference 1, critical heat flux values and transition
boiling heat transfer coefficients have been computed
from those data obtained with the 3/4-inch nominal
diameter boiler tube in which the critical heat flux
was exceeded. These results are presented in Table 1
of this report,

As a first step in the treatment of the critical
heat flux data, a correlating factor to account for the
effect of the helical insert was sought. Theoretical

treatment (Reference 5) and experimental studies
(Reference 6) of the critical heat flux phenomenon
in pool boiling indicate that the critical heat flux
increases as the local acceleration or gravity in-
creases. Specifically, the critical heat flux
increases as the fourth root of the local acceleration.
It is logical, therefore, to attempt correlation of
forced convection critical heat flux data with vortex-
generator inserts in terms of the radial acceleration
at the tube wall developed by the insert.

Figure 7 shows the critical heat flux values
obtained with the 3/4-inch nominal diameter boiler
tube, both with and without a helical insert of pitch-
to-diameter ratio equal to six (P/D = 6). The critical
heat flux values obtained with this insert were divided
by the fourth root of the radial acceleration (a),
derived in Appendix A, employing a slip ratio (K) equal
to the square root of the ratio of liquid to vapor
densities. It can be seen from the Figure that the
correlating technique brings the data obtained with the
insert into agreement with the values obtained without
insert. This relationship indicates a decrease in
critical heat flux as the local quality at the critical
heat flux point is increased. The data shown in Figure 7
are presented in two plots, one with temperature at
the critical heat flux point as a parameter, and the
second with potassium mass velocity as a parameter. No
definite grouping of the values with respect to either
parameter is observed. Thus the effect of temperature
and mass velocity upon the critical heat flux within

the range of the variables covered is less than the scatter of the data obtained. The correlating lines drawn through the data presented in Figure 7 are given by the following equation where q_c'' is the critical heat flux and X_c the vapor quality at the critical point.

$$\frac{q_c'' \, (\frac{X_c}{1-X_c})}{\sqrt[4]{a}} = 3.5 \times 10^5 \, \frac{Btu}{hr-ft^2} \qquad (9)$$

The parameter $\sqrt[4]{a}$ in equation (9) is defined as 1.0 for boiling without inserts.

More extensive and accurate data, as well as additional analysis are needed to verify and improve both the correlating technique utilized for the insert data and the conclusions cited above. These initial results are encouraging, however, and are applicable to boiler design studies, since these relationships were obtained for data which was taken under two-fluid boiling conditions similar to those which will exist in a space power system potassium boiler.

III 100 KW PROJECT
J.A. Bond

The 100 KW Facility is a single loop system used to
study heat transfer to boiling alkali metals at temperatures
up to 2100°F. The radiation heated boiling test section is
currently (6/30/65) a 3/4-inch Schedule 80 (0.74-inch I.D.,
30-inch heated length), Cb-1%Zr pipe containing an instrumented
insert. Thermocouples are attached on the outer wall of the
test section and fluid temperatures are measured with insert
thermocouples. A preboiler, located upstream of and in series
with the test section, controls the enthalpy of the fluid
entering the test section. The working fluid is potassium.

Status of Loop and Test Section

Tests with the 3/8-inch (0.42-inch I.D., no insert) test
section were completed on April 2, 1965 (Test Set No. 3). The
loop was shut down throughout April in order to install Test
Section No. 4. This test section is a 3/4-inch (0.74-inch I.D.,
30-inch heated length) pipe containing an instrumented plug-
helix insert. The insert consists of an inlet plug (Figure 36)
which forms an annular flow passage extending over half of the
heated length, followed by a helix (P/D = 2) which extends over
the remaining half of the heated length downstream of the inlet
plug (Figure 35). A total of five Pt-Pt10%Rh thermocouples are
contained within the centerbody of the insert, distributed along
the heated length. Further details of Test Section No. 4 and its
instrumentation can be found in Sections V and VI of this report.
Boiling operation with Test Section No. 4 began on May 10 and
the planned experiments were completed on June 10. The loop was
shut down during the remaining part of June for the changeover to

Test Section No. 5, the last test section in the currently contracted test program.

Test Section No. 5 is a 3/4-inch (0.74-inch I.D., 30-inch heated length) pipe containing an instrumented insert. The insert (Figure 38) consists of an inlet plug wrapped with wire which will force the potassium to flow in a helical path through the annular flow passage formed between the plug and the pipe inside wall. This geometry extends over the lower half of the 30-inch heated length. The wire coil (P/D = 2, 0.094-inch) wire diameter) continues over the remaining half of the test section, but without the plug. Test Section No. 5 includes a radiant-heated nucleator of the "hot-finger" type located between the preboiler outlet and the test section heated zone inlet. The hot finger will not be used initially but will be used later for further boiling inception studies. Further details of Test Section No. 5 and its instrumentation can be found in Sections V and VI of this report.

Testing with Test Section No. 5 is scheduled to begin early in July. This is the last of the currently-contracted experimental work in the 100 KW Facility. The following table summarizes the test sections which have been used under the current program since installation of the preboiler in August, 1964.

100 KW Facility Test Sections

No.	Heated Length Inches	Inside Diameter Inches	Insert
1	30	0.77	None
2	30	0.74	Helical - P/D = 6
3	30	0.42	None
4	30	0.74	Instrumented Plug-Helix (P/D = 2)
5	30	0.74	Instrumented Plug-Wire Coil (P/D = 2)

During the Quarter, the 100 KW Facility was operated a total of 535 hours including 450 hours under boiling conditions. Total facility operating time at the end of the Quarter was 5897 hours.

Status of Data Reduction

Reduction of the data obtained with the 3/8-inch (0.42-inch I.D.) test section is complete and the results are presented herein. The data obtained with Test Section No. 4 are being processed and will be reported in the next Quarterly Progress Report.

Status of Data Evaluation

Nucleate Boiling Results. The nucleate boiling data obtained in Test Section No. 3 (0.42 I.D.) are tabulated in Tables B-3a through B-3d . The data include points taken at two saturation temperatures, three mass velocities and three heat fluxes. The general test procedure was to hold saturation temperature, mass velocity and test section heat flux constant while the quality at the boiler exit was changed by varying the pre-boiler power. Figure 8a is a plot of the data taken at T_{sat} = 2100°F, G = 60 lb/sec-ft^2 with heat flux as parameter. No definite trend with heat flux is apparent, as has been previously observed in the 3/4-inch test sections. The data taken at G = 30 lb/sec-ft^2 are presented in Figure 8b which includes points taken at T_{sat} = 1800°F and at T_{sat} = 2100°F. The heat transfer coefficients at 2100°F are generally lower than the corresponling points at G = 60 lb/sec-ft^2, suggesting a mass velocity effect. The data at T_{sat} = 1800°F show a considerable scatter at the highest quality tested. The heat transfer coefficients at 1800°F are generally higher than the corresponding points at 2100°F. Figure 8c is a plot of the data taken at T_{sat} = 2100°F and

$G = 45$ lb/sec-ft^2. The heat transfer coefficients appear to
have a maximum at about 50% quality. Examination of these
data, however, reveals that there was a considerable variation
in wall temperature measured at the same axial position. For
the data at $G = 45$ lb/sec-ft^2, the wall-to-fluid ΔT's measured
at an axial station approximately 2-inches from the test section
outlet varied from about $0.3°F$ to $8°F$. At the same axial location,
there were circumferential variations on the order of $3.5°F$. A
detailed discussion of the probable errors in temperature measure-
ment in the 100 KW Facility is presented in Section VIII of this
report.

Critical Heat Flux, Film Boiling and Superheat Results. Due
to the higher heat fluxes obtainable with the 3/8-inch test
section (Test Section No. 3), this test set resulted in a number
of critical heat flux determinations. Also, for the first time
in the 100 KW Facility, superheated vapor conditions were obtained
at the test section outlet. Recorder charts showing the behavior
of pertinent system parameters were made during each run in which
the critical heat flux condition was reached or exceeded. Segments
of these recorder charts are presented as Figures 9 through 15b.

Although there are exceptions, the general test procedure
was an extension (to higher qualities) of the procedure used
to obtain nucleate boiling data; i.e., the saturation temperature,
mass velocity and test section heat flux were held constant while
the quality was increased by slowly increasing the preboiler
power until the critical quality corresponding to the test
conditions was reached. During the initial runs, the test was
usually terminated when the amplitude of the wall temperature
oscillations reached values on the order of $50°F$ to $100°F$. Later,
after some experience was gained, it was possible to go beyond

the transition boiling regime and establish stable film
boiling and superheated vapor conditions in the test section.
One such run, in which superheated vapor conditions were
obtained, will be discussed in detail because it illustrates
the general behavior of the test section wall temperature as
conditions are changed sequentially from the nucleate boiling
regime into transition boiling, stable film boiling and finally
into the superheated vapor condition. Deviations from this
general behavior will be noted on runs in which they occurred.

Figures 14a, 14b and 14c consist of segments of recorder
charts obtained during a "superheat run". The test conditions
for this run were T_{sat} = 2100°F, G = 47.6 lb/sec-ft^2 and
q" = 50,000 Btu/hr-ft^2. Segment - 1 of Figure 14a shows the
system parameters as the test section heat flux was being
increased to test conditions. Before the test section power
increase, the wall temperature near the outlet was steady.
After the test section power increase (Segment-1, Figure 14a)
small oscillations ($\sim$5°F) in the wall temperature began to
appear, indicating that the critical heat flux condition was
imminent. Segment-2 of Figure 14a shows the behavior after the
test section heat flux had been increased to test conditions
(q" = 50,000 Btu/hr-ft^2). From this point on, the test section
heat flux was held constant and the quality was varied by
varying the preboiler power.

In Segment-2, the exit quality was increased from 86% to
89% with a resulting increase in the amplitude of the wall
temperature oscillations. Note that immediately following the
power increase (Segment-2), the amplitude of the wall temperature
oscillations reached values up to about 50°F and then became

more steady. This type of behavior has been observed in most of the critical heat flux runs; i.e., the wall temperature may show relatively large oscillations immediately following a power increase and then again became steady after a short interval. In Segment-3 of Figure 14a , the exit quality was increased from 89% to 91%. At this point, the amplitude of the wall temperature oscillations increased markedly to values of about 75°F with a peak of almost 150°F, indicating that the test section outlet region was definitely in the transition boiling regime.

Figure 14b is a continuation of Figure 14a. At 1342 hrs. the exit quality was increased to 96% (Figure 14b). As can be seen, the exit wall temperature began to rise rather rapidly, indicating that the test section outlet region was going into stable film boiling. The wall temperature at the exit then recovered, oscillated a few times, again began to rise and finally leveled off in stable film boiling. During this temperature transient, the digital voltmeter was printing the wall temperature at a rate of three readings per second. The film boiling heat transfer coefficient at this point was calculated from the temperature measurements to be 228 Btu/hr-ft^2-^{O}F. Note that at this point (Figure 14b), the test section exit was in stable film boiling while the midpoint was still in the first stages of transition boiling, with random temperature oscillations of up to 50°F maximum.

At 1349 Hrs. (Figure 14b), the preboiler power was again increased, resulting in a calculated test section exit quality greater than 100% and a measured exit vapor superheat of 25°F. When 100% exit

quality was reached, the fluid temperature at the test section
outlet began to oscillate and increase, (Figure 14b). The exit
wall temperature at this point is off-scale on the recorder chart.
Note that the test section midpoint quality is 95% and the corres-
ponding wall temperature oscillations have an amplitude of up to
150°F. In Segment-5 of Figure 14b, the power was increased further
resulting in a vapor superheat of approximately 200°F. This was
the highest exit vapor superheat reached in this test.

In Figure 14c, the quality was reduced in steps to repeat
in reverse the sequence of events observed while going up in
preboiler power. In Segment-7 of Figure 14c, the exit quality
was reduced from 102% to 95%. At this point, the test section
midpoint was back in transition boiling while the exit was still
in stable film boiling. In Segment-8 of Figure 14c, the exit
quality was reduced from 95% to 93%. At this point, the test
section exit came out of film boiling into transition boiling.
Note that this change from film to transition boiling occurred
at about the same quality as the corresponding change from
transition to film boiling effected earlier by increasing the
quality (Segment-4 of Figure 14b). Segment-9 of Figure 14c
shows the decrease in exit quality from 87% to 84%. At this
point, the amplitude of the exit wall temperature oscillations
dropped from values as high as 100°F down to random oscillations
of about 25°F.

The general behavior of the test section wall temperature,
as illustrated by the test run described above, is typical of
that observed in most of the runs on which the critical heat
flux condition was reached or exceeded. Although there are
exceptions, it appears that after the transition boiling regime
begins, the wall temperature oscillates within an envelope for

which the upper temperature bound increases with increasing
quality and a lower bound which is approximately constant
at the level corresponding to that for nucleate boiling, as
illustrated in sketch A below.

$$X_1 < X_2 < X_3 \cdots$$

Wall-to-Fluid ΔT

X_1 — X_2 — X_3 — X_4

Time ⟶
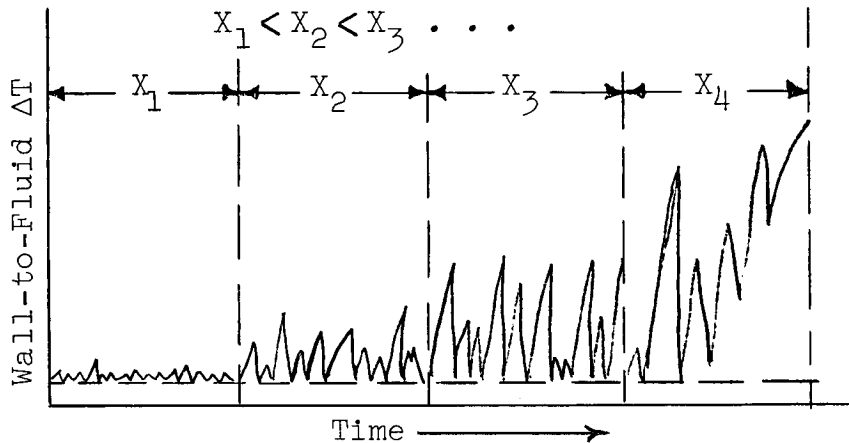
T_{sat}, G and q" constant

Sketch A

This same information, plotted as ΔT vs. X might appear
as shown in sketch B below:

Wall-to-Fluid ΔT

Film Boiling ΔT

Upper Bound of
Temperature
Oscillations

Lower Bound of
Temperature
Oscillations

Nucleate
Boiling ΔT

Quality, X, ⟶

X_c X_D X_{FB}
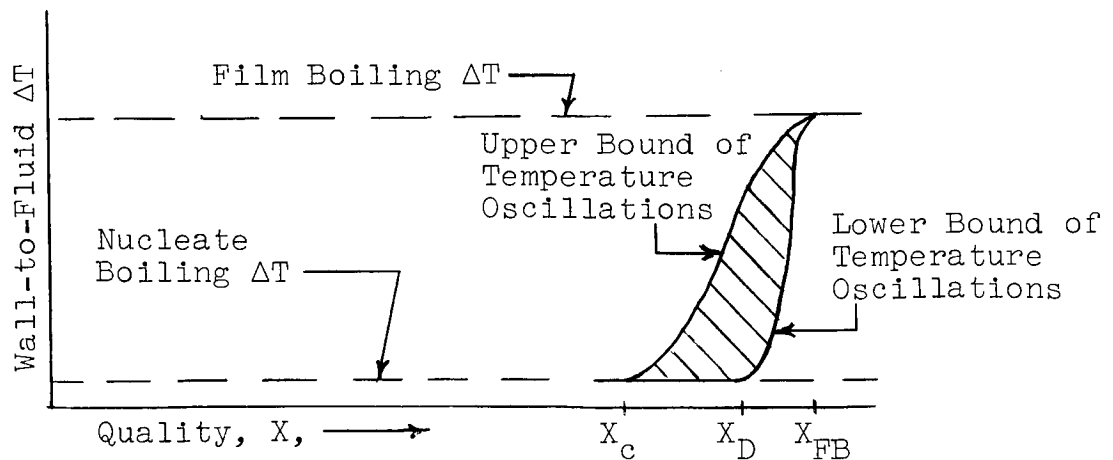
T_{sat}, G and q" constant

Sketch B

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Sketch B is undoubtedly an oversimplification because the film boiling and the nucleate boiling ΔT's are not necessarily independent of quality even at constant T_{sat}, G and q''. The sketch does, however, illustrate the concept. With T_{sat}, G and q'' constant, the wall temperature apparently starts oscillating (over and above the small random oscillations associated with nucleate boiling) at some "critical quality", X_c. As the quality is increased to values greater than X_c, the amplitude of the oscillations increases but the lower bound remains essentially constant until at some higher quality X_D (see sketch B), the lower bound of the oscillations begins to increase. Above this point (X_D), the <u>amplitude</u> of the oscillations begins to diminish, but the average wall temperature increases. Finally, at a quality X_{FB}, the wall temperature becomes steady at the film boiling value.

As mentioned previously, there are apparent exceptions to this general behavior. In some cases, the wall temperature will increase abruptly when the critical quality, X_c, is reached. Evidence of this phenomenon is presented in Figures 12, 15a and 15b . In Figure 15a, for example, the heat flux was constant at 211,000 Btu/hr-ft^2. After the preboiler power increase (quality increase), the wall temperature began to rise rapidly ($\sim 175°$F in 3 sec.). Presumably, if the automatic test section power trip had not reduced the heat flux, the test section would have gone into stable film boiling. This type of behavior has been observed in the runs for which the heat flux was relatively high (with correspondingly lower X_c). A plausible explanation of the two types of behavior can be made with the aid of Sketch C.

$$q_1'' < q_2'' < q_3''$$
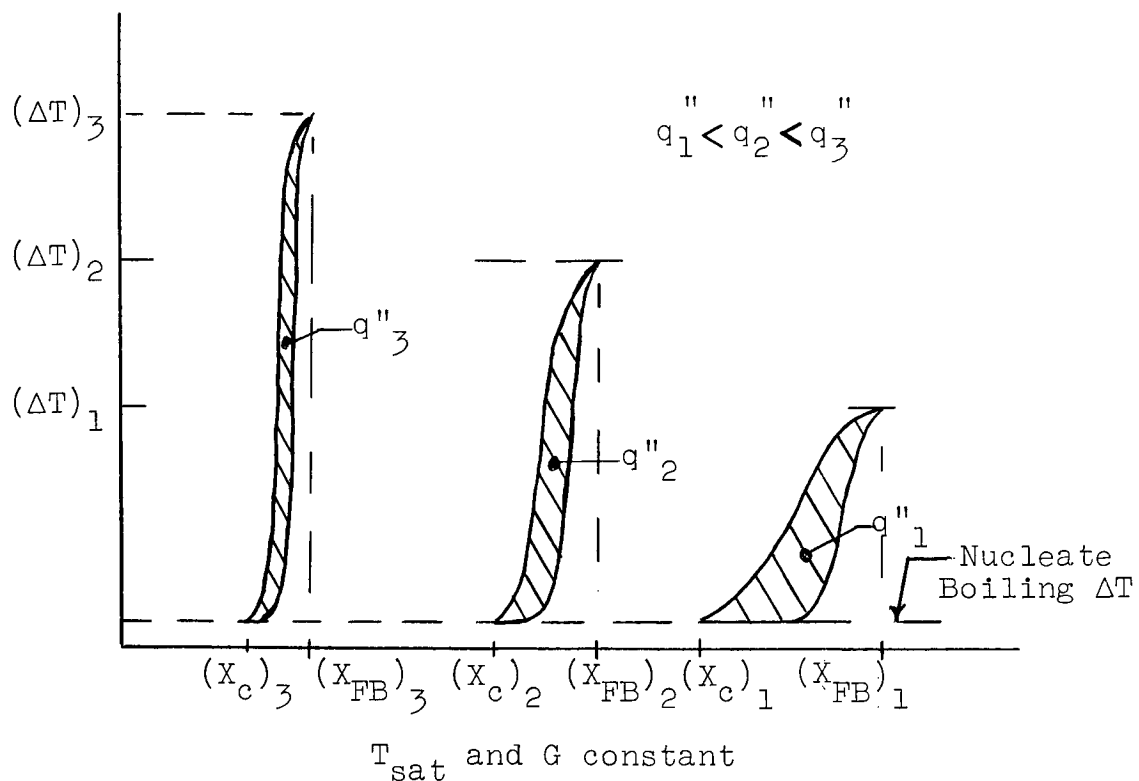
T_{sat} and G constant

Sketch C

Consider a hypothetical experiment in which T_{sat} and G are held constant. Three critical heat flux runs are to be made at the three heat fluxes q_1'', q_2'' and q_3'' where $q_1'' < q_2'' < q_3''$. The results of this experiment might appear as shown in Sketch C. At the lowest heat flux, the critical quality, "film boiling quality" and film boiling ΔT are $(X_c)_1$, $(X_{FB})_1$ and $(\Delta T)_1$ respectively. The corresponding parameters for the other two heat fluxes are as indicated in Sketch C. If the results of this experiment were as shown in Sketch C, then the abrupt temperature rise which has been observed at the higher heat fluxes would be explained by the fact the upper bound of the ΔT vs. X curve is so steep (at high heat fluxes) that only a small change in quality would result in a sharp rise in the wall temperature. The question to be answered is what evidence do we have to justify the _relative_ relationships implied by Sketch C. The first implication of Sketch C is that the critical quality, X_c, decreases with increasing heat flux at constant T_{sat} and G. Although this implied relationship has nothing to do with the slope of the upper bound of the ΔT vs. X curve, there is direct evidence that X_c does in

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fact decrease with increasing heat flux for constant T_{sat} and G. This will be discussed later. The second implication of Sketch C is that the film boiling ΔT increases with increasing heat flux. The film boiling ΔT has been measured in the lower heat flux ranges of q" = 50,000 Btu/hr-ft^2 and q" = 100,000 Btu/hr-ft^2 and the results confirm that the film boiling ΔT does increase with increasing heat flux. A third implication of Sketch C is that the quantity $(X_{FB} - X_c)$ decreases with increasing heat flux at constant T_{sat} and G. The strongest piece of evidence to support this contention is the observation that in the relatively high heat flux runs, the wall temperature showed an abrupt rise without the oscillations discussed previously. This indicates that under those conditions (high heat flux), the critical quality, X_c, is nearly equal to the film boiling quality, X_{FB}. Further evidence of the trend of $(X_{FB} - X_c)$ with heat flux is lacking.

The critical heat flux measurements obtained in the 100 KW Facility are tabulated in Table 2 . These include all critical heat flux determinations made with Test Sections No. 1, No. 2 and No. 3. Supporting evidence, in the form of recorder charts are presented in Figures 9 through 15b for those runs which have not been previously reported.

In most of these runs, the critical heat flux condition was indicated by wall temperature oscillations. For these runs, the question which immediately arises is what quality to call the "critical quality" for a given T_{sat}, G and q". Until the phenomenon is better understood, the decision must be somewhat arbitrary. The criterion which has been selected as a working definition for the present is that for a given heat flux the "critical quality" is that quality for which the "time-average" fluctuating wall-to-fluid ΔT becomes approximately equal to twice

the corresponding steady-state nucleate boiling ΔT based on a nucleate boiling heat transfer coefficient of 10,000 Btu/hr-ft^2-$^\circ$F. For example, for a heat flux of 100,000 Btu/hr-ft^2 the above criterion would require that at the "critical quality" the "time-average" wall temperature be approximately 10°F higher than the corresponding nucleate boiling value.

For data reduction purposes, the time-average of the fluctuating wall temperature at the critical heat flux condition is estimated from the Sanborn recorder charts made for each of the test runs. The value of 10,000 Btu/hr-ft^2 - $^\circ$F chosen as the steady-state nucleate boiling heat transfer coefficient for use in the critical heat flux condition determinations is adequately representative of the magnitudes measured in the ranges of heat fluxes, saturation temperatures and vapor qualities tested, and is taken as a constant for convenience.

The critical heat flux data in Table 2 are presented on the basis of the above definition. These data, along with the critical heat flux data from the 300 KW Facility (see Section II) are plotted in Figure 16 as $q_c''/\sqrt[4]{a}$ vs. local quality. The relative centripetal acceleration, a, is as defined and derived in Section II of this report for use in treating the data taken with helical insert geometries. The values of $\sqrt[4]{a}$ for the insert data are tabulated in Table 2; for the no-insert data $\sqrt[4]{a}$ is taken to be 1.00. Use of the quantity $\sqrt[4]{a}$ is an attempt to allow for the centrifugal action of the helical insert tending to keep liquid on the wall of the test section. Further discussion of this point is given in Section II in conjunction with treatment of the critical heat flux data from the 300 KW Facility.

The critical heat flux data presented in Figure 16 shows fairly good agreement between the data taken in the 300 KW Facility

and that taken in the 100 KW Facility considering the wide range of test conditions covered and the completely different methods used to detect the phenomenon.

Further examination of the 100 KW data suggested the presence of apparent mass velocity and saturation temperature effects. In an initial attempt to correlate these effects, the concept of a maximum rate-of-change of quality was introduced. From a simple energy balance over an increment of heated length d'z, the rate of change of quality is given by:

$$\frac{dx}{dz} = \frac{4q''}{DG\ h_{fg}} \tag{1}$$

The __maximum__ rate-of-change of quality without exceeding the critical heat flux is given by:

$$\left(\frac{dx}{dz}\right)_{max} = \frac{4q''_c}{DG\ h_{fg}} \tag{2}$$

The critical heat flux data have been plotted in Figure 17 with $q''_c/DG\ h_{fg}\ \sqrt[4]{a}$ as the dependent variable and quality as the independent variable. This type of plot appears to remove the mass velocity dependence, but apparent tube diameter and temperature effects remain.

One might expect that the critical heat flux should be a function of the liquid film thickness on the wall. In another attempt to correlate the data, a liquid film thickness was calculated using the definition of the void fraction and assuming no liquid is entrained in the vapor phase. The resulting thickness, δ, is given by:

$$\delta = 1/2\ (1 - \sqrt{Rg})\ D_i \tag{3}$$

The void fraction, Rg, was calculated from

$$Rg = \frac{1}{1 + K \left(\frac{\rho_g}{\rho_f}\right)\left(\frac{1-x}{x}\right)} \qquad (4)$$

with the assumption that the slip ratio, K, is equal to $\sqrt{\rho_f/\rho_g}$. The critical heat flux data are plotted in Figure 18 as a function of liquid film thickness with $q_c^{''}/DG\ h_{fg}\ \sqrt[4]{a}$ as the dependent variable. This type of correlation appears to reduce the scatter and shows the trend one might expect. Further evaluation of the data is proceeding, including comparisons with critical heat flux data obtained in the 300 KW Facility.

One aspect of the critical heat flux phenomenon which needs further evaluation is the question of flow stability. During at least two of the critical heat flux runs presented herein, flow oscillations indicated that the system stability was marginal. For example, in Figure 9 , the average flow oscillations were on the order of $\pm$ 7% with maximum oscillations up to about $\pm$ 13%. Another type of possible instability is indicated in Figure 12 . Here, the system pressure level dropped almost simultaneously with the sharp wall temperature excursion at the test section outlet. It is not known in this instance whether onset of the critical heat flux condition was a cause or was an effect of system instability.

In the preceding discussion, mention was made of the "film boiling quality", X_{FB}, or the quality at which "transition boiling" terminated and "stable film boiling" was established for a given set of test conditions. This data on stable film boiling inception is tabulated in Table 3 along with film boiling and superheated vapor heat transfer coefficients calculated from the measured temperatures.

IV 50 KW PROJECT
S.G. Sawochka

Status of Loop and Test Section

Completion during March 1965 of the test series with
the 5/8-inch I.D. test section with 1/4-inch O.D. tubular
instrumented insert (Test Set No. 5) concluded the currently
planned test program in the 50 KW Facility. The facility was
then shutdown, in good working order. A summary description
of the test sections used for the five test sets constituting
the test program under the 50 KW Project is given in Appendix G.

Status of Data Reduction

All data have been reported, with the last two data sets
for Test Sets No. 4 and No. 5 presented in Reference 7. The
data for Test Sets No. 2 and No. 3, the 5/8-inch I.D. tube with
tapered pin insert and the 3/8-inch I.D. plain tube (no insert),
respectively, have been re-evaluated and corrected to include the
effect of the pressure change on the inlet vapor temperature due
to the presence of the inlet temperature measuring probe. The
re-evaluated data for Test Sets No. 2 and 3 are presented in
Appendix D.

To evaluate the data for heat transfer analysis, accurate
values of the thermal conductivity of the Nickel 270 condenser
tube material are required. Therefore, a specimen of the
material used to manufacture the tubes was sent to Battelle
Memorial Institute for determination of its thermal conductivity
as a function of temperature.

The method of making the thermal conductivity measurements,
in brief consisted of heating one end of a specimen, measuring

the temperature gradients along the specimen, and determining
the rate of heat flow through the specimen by means of a metal
standard of known thermal conductivity attached to the cold
end of the specimen.

Errors of thermal-conductivity measurements are estimated
to not exceed ± 5 percent, the chief uncertainty being the
thermal conductivity of the reference material.

The results of these measurements are given in Figure 19.

Status of Data Evaluation

A.   Heat Transfer

As discussed in Reference 7, the data of Test Sets No. 1,
No. 2 and No. 3, with no instrumented insert, are subject to two
errors. One error is due to the presence of the temperature
measuring probe at the test section inlet which had an effect on
the inlet potassium pressure with a consequent error in saturation
temperature measurement. The other error is due to the assumption
of a linear temperature profile between the test section inlet and
outlet. To determine the importance of the first error, a sample
thermocouple probe was installed during Test Set No. 5, as
discussed in Reference 7. The results of this test indicated that
the potassium vapor temperature increased by as much as $4^{\circ}F$ between
the tip of the inlet temperature probe and a point 2-inches down-
stream, thereby indicating a net pressure increase, as would be
obtained with single-phase flow through an expansion. The area
ratio, A_2/A_1, for this test was 1.19, for the 1/4-inch O.D. probe
in the 5/8-inch I.D. pipe. For application to the data of Test
Sets No. 2 and No. 3, an attempt was made to correlate the
experimental results using the following single phase relations.

$$p_2 - p_1 = \frac{G_1^{\,2}}{2\rho_g \, g_c} \left[1 - \left(\frac{A_1}{A_2}\right)^2 - K_E - \frac{4fL}{D}\left(\frac{A_1}{A_2}\right) \right] \qquad (1)$$

For the range of vapor Reynold's numbers during the test, this equation can be approximated by

$$p_2 - p_1 = 0.21 \frac{G_1^{\,2}}{2\rho_g \, g_c} \qquad (2)$$

The results of this comparison using equation (2) gave reasonable agreement with the test data, with a maximum deviation of $0.7^{\circ}F$. This procedure was then applied to Test Sets No. 2 and No. 3, and the re-evaluated data are presented in Appendix D, and in Figure 20. It was not necessary to apply this procedure to the results of Test Set No. 1 since the area ratio for this series of tests was only 1.04, thereby giving a negligible temperature increase due to the expansion.

As can be seen in Appendix D and also in Figure 20, the condensing heat transfer coefficients for Test Sets No. 2 and No. 3 are generally greater than 10,000 Btu/hr-ft-$^{\circ}$F, which agrees in this respect with the data of Test Sets No. 1, No. 4 and No. 5. However, they exhibit a considerable amount of scatter, since a major source of error for this data was the estimate of the local potassium temperature from the measured inlet and outlet temperatures. In addition to the large scatter, a considerable number of the calculated heat transfer coefficients for Test Sets No. 2 and No. 3 are negative due to the combination of temperature measuring errors. Since this source of error was remedied during the instrumented insert data runs (Test Sets No. 4 and No. 5), no further treatment of the data for Test Sets No. 2 and No. 3 is planned.

In an initial attempt to obtain a definite reason for the departure of the experimental condensing heat transfer coefficients from the film theory predictions of Nusselt and Seban, the results for Test Sets No. 4 and No. 5, which are believed to be the most accurate, were treated in the following manner:

1. An estimate of the liquid film thickness based on the prediction of Dukler (Reference 8) was made and a liquid film heat transfer coefficient was calculated by using $h = K/\delta$. Although Dukler's thermal analysis of the condensing phenomenon is grossly in error for low Prandtl number fluids as has been shown by Lee (Reference 9), his hydraulic analysis which accounts for shear at the vapor-liquid interface appears to correlate film thickness data. For this reason Dukler's film thickness prediction was used to estimate the liquid film thermal resistance. The predicted liquid film Nusselt condensing ratio, $h/K(\nu^2/g)^{1/3}$, is presented in Figure 21 as a function of $\mathcal{T}_v^*$ using Reference 8, where

$$\mathcal{T}_v^* = \frac{\mathcal{T}_v}{(\rho \frac{\nu^2}{g})^{1/3}} \tag{3}$$

and

$$\mathcal{T}_v = (\frac{dP}{dL}) (\frac{D_i - D_{cb}}{4}) \tag{4}$$

To determine h_f for the data of Test Sets No. 4 and No. 5, the local friction pressure gradient was estimated by

$$(\frac{dP}{dL})_v = \frac{f}{(D_i - D_{cb})} \frac{\rho_g V_g^2}{2g_c} \tag{5}$$

where

$$V_g = \frac{4x \; W_K}{\rho_g \; \pi \; (D_i^2 - D_{cb}^2)} \qquad (6)$$

This method gives a low-side estimate of $\mathcal{T}_v^*$ thereby maximizing the liquid film thickness and consequently its thermal resistance.

2. The experimental thermal resistance was taken to be the sum of a liquid-phase and a vapor-phase thermal resistance

$$\frac{1}{h_c} = \frac{1}{h_f} + \frac{1}{h_v} \qquad (7)$$

3. A residual thermal resistance, proposed to be due to the vapor phase, was calculated by subtracting the liquid film thermal resistance from the experimental values of the total condensing thermal resistance.

In order to compare with theory the vapor-phase resistances derived from the experimental data, a theoretical prediction was formulated on the basis of kinetic gas theory following a procedure suggested by the work of Schrage and used by Rohsenow and Sukhatme (References 10 and 11), as follows.

From kinetic gas theory, the mass flow of molecules impinging on a surface is given by equation 8:

$$G = P \; (\frac{Mg_c \; J}{2\pi RT})^{\frac{1}{2}} \qquad (8)$$

The mass flux, saturation temperature relationship is shown in Figure 22 for potassium.

When equilibrium exists between a saturated gas and its liquid, the mass flux of molecules leaving the liquid surface equals the mass flux of vapor molecules condensing on the liquid surface, i.e., the net rate of heat transfer is zero. This equality is expressed by Equation 9:

$$P_s \left(\frac{Mg_c J}{2\pi R T_s}\right)^{\frac{1}{2}} = P_v \left(\frac{Mg_c J}{2\pi R T_v}\right)^{\frac{1}{2}} \tag{9}$$

However, when a net rate of mass transfer occurs such as in the case of condensation, a condition of nonequilibrium exists at the liquid-vapor interface. This nonequilibrium condition is expressed by

$$P_v \left(\frac{Mg_c J}{2\pi R T_v}\right)^{\frac{1}{2}} \succ P_s \left(\frac{Mg_c J}{2\pi R T_s}\right)^{\frac{1}{2}} ; \tag{10}$$

or, approximately, by

$$W/A = \delta_c P_v \left(\frac{Mg_c J}{2\pi R T_v}\right)^{\frac{1}{2}} - \delta_e P_s \left(\frac{Mg_c J}{2\pi R T_s}\right)^{\frac{1}{2}} \tag{11}$$

where:

W/A = mass units/unit time/unit area condensing

P_v = pressure of the saturated vapor in the bulk space

T_v = temperature of the saturated vapor in the bulk space

T_s = temperature of the liquid at the liquid vapor interface

P_s = saturation pressure corresponding to T_s.

δ_c = condensation coefficient, fraction of the molecules striking the surface which actually condense

δ_e = evaporation coefficient, fraction of the predicted molecular flux from the liquid surface which actually leaves the surface

The inequality of mass flux at the liquid-vapor interface has been expressed more accurately by Schrage who visualizes the saturated vapor stream at T_v moving toward the condensing surface at a flow rate of W/A with a counter flow of molecules at T_s from the surface as being the flow equivalent of molecules in a stationary container. Schrage's relation is given by Equation 12:

$$W/A = 6_c \, P_v \left(\frac{Mg_c J}{2\pi RT_v}\right)^{\frac{1}{2}} - 6_e \Gamma P_s \left(\frac{Mg_c J}{2\pi RT_s}\right)^{\frac{1}{2}} \qquad (12)$$

where

$$\Gamma = \text{EXP} \left\{ - \phi^2 \right\} + \phi \pi^{\frac{1}{2}} (1 + \text{erf } \phi)$$

and

$$\phi = \frac{W/A}{\rho_g (2RT_v/g_c JM)^{\frac{1}{2}}}$$

As can be seen by examining Equations 11 and 12, the only difference that exists is a function ϕ in Schrage's equation which attempts to account for the presence of a net progress velocity of the condensing gas towards the surface. The range of heat fluxes or net velocities towards the surface that were present during this test series gives very low numerical values for ϕ, which yield a value of Γ approaching unity. For this reason Equation 12 can be simplified to yield Equation 11, which was given as the approximate relation for a simplified treatment. In order to determine a numerical value for the temperature difference between the vapor and the liquid that exists due to the presence of a net heat transfer rate, some assumption must be made regarding the values of 6_c and 6_e. It can

be shown that at equilibrium $\sigma_c = \sigma_e$. Therefore, under non-equilibrium conditions with a net rate of condensation, it will be __assumed__ that the condensation and evaporation coefficients are equal. With this assumption Equation 12 can be simplified to give Equation 13:

$$W/A = \sigma_c \left[P_v \left(\frac{Mg_c J}{2\pi RT_v}\right)^{\frac{1}{2}} - P_s \left(\frac{Mg_c J}{2\pi RT_s}\right)^{\frac{1}{2}} \right] \tag{13}$$

$$W/A = \sigma_c \Delta \left[P \left(\frac{Mg_c J}{2\pi RT}\right)^{\frac{1}{2}} \right] \tag{14}$$

Equation (14) can be rewritten in terms of the condensing heat flux, as follows:

$$q'' = \sigma_c \Delta \left[h_{fg} P \left(\frac{Mg_c J}{2\pi RT}\right)^{\frac{1}{2}} \right] \tag{15}$$

Since P and T are related by the saturation curve, or $P = f(T)$, Equation 16 is obtained as follows,

$$q'' = \sigma_c \Delta T \left(\frac{\Delta G \cdot h_{fg}}{\Delta T}\right) \tag{16}$$

$$\frac{q''}{\Delta T} = h_v = \sigma_c \left(\frac{\Delta G \cdot h_{fg}}{\Delta T}\right) \tag{17}$$

To quantitatively determine the value of h_v, the effective kinetic theory heat transfer coefficient, it is necessary to determine the value of $\Delta G h_{fg}/\Delta T$. Since the vapor kinetic theory mass flux can be calculated from Equation 8, its derivative with respect to temperature can be numerically determined, and the equivalent

interfacial thermal resistance can be calculated as a function of saturation temperature. The results of this calculation are presented in Figure 23 as a function of saturation temperature and δ_c, the condensation coefficient. It should be noted that for values of δ_c near unity, the kinetic theory heat transfer coefficient is high and would afford an insignificant thermal resistance during the condensing process. However, as the value of δ_c decreases the effective interfacial heat transfer coefficient decreases and could afford a substantial thermal resistance if ideal kinetic theory behavior was not followed.

In Figure 24, the experimental vapor phase heat transfer coefficients of Test Sets No, 4 and No. 5 are compared to the calculated value of the vapor phase heat transfer coefficient for $\delta_c = 0.2$. Also included are the low-temperature data of Englebrecht (Reference 24). Reasonably good agreement between the experimental data and the theoretical prediction using the selected value $\delta_c = 0.2$ is shown. A trend of decreasing vapor-phase condensing coefficients with decreasing saturation temperature is indicated. Table 4 lists summarized results for Test Sets No, 4 and No. 5 with the experimental values of δ for each data point.

An alternate approach to assuming $\delta_c = \delta_e$, as used above for the theoretical analysis is to assume instead that deviations from ideality occur in the vapor-phase only, i.e. $\delta_c < 1$ and $\delta_e = 1$. To show the effect of this, vapor heat transfer coefficients corresponding to values of the condensation coefficient 0.95 to 1.0 are presented in Figure 25. Figure 25 shows that as δ_c is reduced from unity increasingly lower values of the vapor phase heat transfer coefficient are obtained.

Even though no rigorous basis exists for the assumption that $\delta_c = \delta_e$, the relative ease of treatment of the data use of this assumption provides justifies its use, pending development of a more rigorous theory.

Further treatment of the data in an effort to assess possible dependence of δ_c on additional variables omitted in the simplified treatment is beyond the scope of the current program. For this reason, the treatment of the vapor-phase heat transfer coefficients was terminated and a correlation of the condensing heat transfer coefficients in the manner suggested by Equation (7) was attempted. The dimensionless relation chosen is given by:

$$N_{NuC} = \frac{1}{\dfrac{1}{N_{NuCf}} + \dfrac{1}{N_{NuCv}}} \qquad (18)$$

where

$$N_{NuCv} = \frac{\delta_c \, (M/2\pi\bar{R}T)^{\frac{1}{2}} \, (dP/dT - P/2T)}{K \, (\gamma^2/g)^{-1/3}} \qquad (19)$$

and

N_{NuCf} = liquid film Nusselt number based on $h_f = K/\delta$

N_{NuCv} = vapor Nusselt number based on kinetic theory prediction and liquid properties

After selection of this relation, the experimental data were treated statistically to determine the value of δ_c which gave

a minimum variance. For the tubular insert data the variance, S^2, defined by

$$S^2 = \frac{\sum\limits_{1}^{N} \left(\dfrac{N_{NuCP} - N_{NuCE}}{N_{NuCP}}\right)^2}{N-1} , \qquad (20)$$

was found to be relatively independent of 6_c for $0.17 < 6_c < 0.22$, with a minimum at $6_c = 0.19$, which gives a standard deviation of 27% and an average error of 22%. Deviations for each data point are listed in Table 5. When this procedure was attempted with the helical insert data, a value of $6_c > 1$ was found to give a minimum variance. Since $6_c > 1$ is physically unacceptable, this method of correlation was abandoned, and the data were compared directly to the predicted liquid heat transfer coefficient. The results of this comparison are presented in Table 5. A meaningful value of 6_c was not obtained from the helical insert measurements, which was not unexpected since the method of estimating the liquid film thickness in the presence of the helical insert was a questionable extension of Dukler's theory of co-current vapor-liquid flow. As can be seen in Table 5, the condensing heat transfer coefficient predicted from Dukler's theory was always greater than the experimentally determined value with the helical insert. A value equal to 40% of that theoretically predicted from Dukler's film thickness estimate was found to correlate the experimental results with a standard error of 23% and an average error of 20%.

The relative importance of the vapor phase heat transfer resistance during the condensation of various fluids shall be discussed. From Equation 17, h_v can be calculated from vapor pressure data for any substance. For example, values of h_v for

water and potassium are presented in Figure 26, with the predicted Nusselt theory condensing heat transfer coefficient for each substance at a film Reynolds number of 10^3 and at a Nusselt number of 0.11. As can be seen, for 6_c = 1.0, the vapor phase heat transfer coefficient for water is 10^2 to 10^4 times as large as the liquid film heat transfer coefficient for $0.1 \lessapprox p \lessapprox 100$ psia and would therefore result in an insignificant thermal resistance during the condensing process even for a value of 6_c = 0.1. Since a value of 6_c = 0.3 has recently been reported for water, (Reference 25) it can be seen that the vapor phase thermal resistance is negligible during the condensation of water and has, therefore, gone unnoticed. However, for potassium for 6_c = 1.0 the vapor phase and liquid film thermal resistance are equal at p = 1.2 psia, and the liquid film thermal resistance is ten times as great as the vapor phase thermal resistance at 30 psia. Therefore, for potassium, the vapor phase thermal resistance is an important portion of the total condensing thermal resistance particularly for $6_c <$ 1 and must therefore, be considered in the correlation of condensing heat transfer data.

B.   Liquid-Vapor Interface Test

As discussed in Reference 7 a test was performed with the tapered pin insert installed in the 5/8-inch diameter tube to determine if it was possible to raise the liquid-vapor interface into the active condensing length approximately 9 inches or 25% of the active condensing length during normal operation without experiencing rapid temperature excursions. The results of the test with the tapered pin insert showed that the liquid-vapor interface could be maintained in the active heat transfer length of the condenser but that careful control of the potassium liquid flow rate from the condenser was required. This same test was

performed with the 3/8-inch I.D. no insert tube test section
and with the 5/8-inch I.D. test section with helical and tubular
inserts. Figure 27 shows the response of various system para-
meters as the liquid vapor interface was raised into the 5/8-inch
I.D. test section. The Sanborn recordings show traces of T_{KI}, T_{NaI},
T_{KO}, W_K, P_{BK}, and three temperature traces of the thermocouples
located in the insert at 5-inches, 10-inches, and 15-inches from
the test section exit. Constant boiler power and sodium flowrate
were maintained while the liquid potassium flowrate from the
condenser was gradually reduced thereby raising the liquid-vapor
interface level from the surge tank into the test section. As
can be seen in Figure 27, after the flow had gradually been reduced
to 56 lb/hr from its initial value of 65 lbs/hr during a period of
approximately 1 hr, the liquid-vapor interface entered the active
heat transfer length of the condenser, as indicated by the drop in
the local potassium temperature at the test section exit to
approximately the sodium inlet temperature. About 30 seconds later
the interface passed the thermocouple 5-inches from the test section
exit. With a subsequent reduction in flow the interface was brought
to a point between 10 and 15-inches from the test section exit and
was stabilized for a period of about 2 hours. The thermocouple
located directly above the interface position indicated approximately
the potassium test section inlet temperature and the thermocouple
below the interface indicated approximately the sodium inlet
temperature. The difference between the two inlet temperatures
was approximately 140°F during this test. As can be seen in
Figure 27, the adjustment of the system to the new interface location
could be brought about gradually, without any serious temperature
excursions, when careful control of the potassium pump was exercised.
After the interface had been maintained between 10-and 15-inches
from the test section exit for the period of about an hour, the

interface was returned to the surge tank by an increase in potassium liquid flow rate from the condenser, and the system returned to its initial operating conditions. The conclusions of this test are:

1. The liquid-vapor interface can be maintained within the active heat transfer length of the test section without the system undergoing substantial temperature excursions.

2. A temperature differential corresponding to approximately the difference between the potassium inlet temperature and the sodium inlet temperature is established over a short axial length increment across the interface.

3. No unexpected system response characteristics were detected when the interface was maintained within the test section.

V. FACILITIES AND INSTRUMENTATION
J.C. Amos/W.H. Bennethum

300 KW Facility

During the quarter the top cover was removed from the
300 KW gas fired sodium heater and the L-605 tube bundle was
inspected visually and by a dye penetrant method. No evidence
of cracks was detected by the dye penetrant inspection and the
tubes showed no signs of thermal distortion. This heater has
operated a total of 4,448 hours at temperatures from 800 to
1850°F.

Nine additional Inco 702, sheathed, MGO insulated, chromel-
alumel thermocouples were installed on the heater tube bundle,
thereby increasing the total number of thermocouples provided
for monitoring tube bundle temperatures to fifteen. The six
thermocouples originally installed had been located on three
tubes near an access port. The nine additional ones were installed
on an even circumferential distribution while access to all tubes
was available during inspection of the tube bundle.

100 KW Facility

Planned tests with the 3/8-inch nominal diameter test section
without insert (Test Section No. 3) were completed April 2, 1965.
This test section was removed and Test Section No. 4, consisting of
a 3/4-inch Schedule 80 pipe with a combination plug-helical insert
(described in detail in Section VI), was installed. This test
section was instrumented with five 0.010-inch diameter Pt10%RH-Pt
thermocouples located in the helix center body tube and plug.
These thermocouples were insulated with high-purity alumina beads
with the junctions spaced over the active length of the test section.
Thirteen 0.005-inch diameter W3%Re - W25%Re thermocouples, insulated
with BeO beads, were attached to the 3/4-inch pipe wall in axial posi-
tions corresponding to the location of the insert thermocouples.

Samples of the Pt10%Rh-Pt thermocouples were calibrated
in freezing point furnaces with the following results:

		Error
Zinc	(787.1°F)	- 0.7°F
Aluminum	(1220°F)	- 0.4°F
Silver	(1761.4°F)	- 1.1°F
Copper	(1981.9°F)	- 3.5°F

The alumina insulators used with the insert thermocouples
were soaked in an oxidizing atmosphere at 2350°F for 2 hours
to remove all contamination and were not touched with bare hands
during installation.

Samples of the W3%Re - W25%Re thermocouples, made from wire
removed from the spools prior to assembly of the test section
thermocouples, were calibrated in a vacuum furnace against 0.020-
inch diameter Pt10%Rh-Pt reference thermocouples. Initial cali-
brations indicated appreciable drift. However, after the thermo-
couples were soaked for approximately 10 hours at 2300°F re-
peatability to within ± 3°F was obtained. Therefore, after
installation of the test section thermocouples the test section
was operated for 24 hours at 2100°F prior to in-place thermocouple
calibration, in order to provide thermocouple stabilization.

Calibration of an additional thermocouple made from wire
removed from the spools after the test section thermocouples were
assembled did not show a change in calibration with successive
thermal cycles and was repeatable with ± 5°F over three cycles.
It is believed that the original wire samples, for which some drift
occurred at the beginning of calibration were not annealed properly

because of their relative positions on the ends of the spools. Therefore, the second calibration is probably more representative of the actual wire characteristics.

During the down-time for the change from Test Section No. 3 to No. 4, the following facility work was performed.

a. New Cb foil was installed on the inside of the condenser louvres.

b. The pneumatic louvre actuation was installed and checked out at room temperature.

c. The test section heat shield, which had been used for the last three test sections was recalibrated for heat losses.

d. A new test section heat shield, which contains ten layers of .005-inch tantalum foil, was installed and calibrated for heat losses. The additional five layers of tantalum reduced the heat losses approximately 10%.

e. The maximum pressure head of the helical induction pump was experimentally determined to be 40 psi for 455 volts at approximately 600°F fluid temperature.

f. The new test section no. 4 was installed and instrumented.

g. A new 0.101-inch diameter diameter orifice was welded into the loop and heat-treated at 2100°F for two hours.

h. The loop was hot-flushed at a maximum temperature of $800^{\circ}F$, after which a sample of the potassium was analyzed. Analysis of the sample indicated 27 parts per million O_2. The potassium was then hot trapped at $1200^{\circ}F$ for 37 hours in the dump tank. Due to the low level of O_2 before hot trapping the potassium was not resampled after hot trapping.

i. A control circuit was added to permit automatic power reduction during any over-temperature condition sensed by either one of two thermocouples attached to the test section wall at the last measuring station within the heated zone, in order to eliminate the possibility of over-heating the test section during critical heat flux determinations or abnormal loop operating conditions. Power cutback is adjustable from zero to approximately 75% of original power setting so that minimum interference with loop operation may be obtained. A detailed description of this circuit is presented below.

The saturable reactor core electrical control system for the test section heater is essentially a variable impedance in series with the load current. Impedance is a function of a small D.C. current through a separate winding on the reactor. The control circuit provides the D.C. current and a means of varying it to control the load current through the main reactor winding. The variable power cut-back control consists of a potentiometer identical to the normal control potentiometer used to vary D.C. output on the standard "Reactrol E" control unit. The "cut-back" potentiometer is switched into the circuit only during an over temperature condition. Power reduction is achieved by setting the "cut-back" potentiometer for a lower value of D.C. output than the standard current limit potentiometer on the "Reactrol E" unit.

The specific components of the added controls and the manner in which they tie in with the "Reactrol E" unit are shown on Figure 28. They include:

1. Two normally open switches, one each attached to a slide wire of a two pen strip chart recorder (measuring loop test section temperature).

2. A triple pole, double throw relay.

3. A 5,000 ohm potentiometer located in parallel with the "Reactrol E" current limit control through a relay contact.

4. A momentary break push button.

5. An indicating light to warn the operator that the power cut back circuit has tripped.

In operation the cut-back circuit is not functional until an over-temperature condition is reached, at which time a normally open switch mounted on one of the recorder slide wires is closed thereby activating the relay and dropping the current limit potentiometer out of the circuit and adding the cut back potentiometer. The net effect of this reaction is equivalent to manually operating the current limit control at the exact instant an over temperature condition at either of two thermocouples which are located at the last measuring station within the heated zone of the boiler is reached. The other contact on the TPDT relay is used to hold the reduced power condition until the reset push button is operated to prevent the power from returning to its original level when the thermocouple indicator falls below the set point.

Thermocouple and flow meter calibration runs for
Test Section No. 4 were started on May 5, 1965 and boiling
test operation was started May 10, 1965. The test plan with
this test section was completed June 10, 1965. Minor inter-
ruptions of test operation were required to repair test section
wall thermocouples, flow meter leads, and to remove Cb foil from
the condenser coil to increase the condensing capacity for high-
power test runs at 1800°F saturation temperature.

All five of the insert thermocouples installed in Test
Section No. 4 survived the test program in good operating condition.
Attempts to remove the thermocouple assembly from the test section
at the end of the test were not successful due to the fact that the
insulators became wedged in the insert tube and the center wire
was broken during the attempted disassembly.

The tungsten coil preboiler radiant heater operated at a maximum
gross electrical input of 60 KW and the test section tungsten rod
radiant heater was operated at a maximum gross electrical power of
32 KW. The preboiler heater has operated a total of 1280 hours and
will be reused for Test No. 5. The test section heater rods ex-
perienced some bowing but can be reused. However, since backup
units have been prepared for both heaters, a new test section heater
will be installed for Test No. 5 and the present heater retained as
the back up.

Test Section No. 5 (to be described in detail in Section VI) was
assembled and installed in the facility and final instrumentation
is in progress. Boiling tests are scheduled to start early in
July. This test section is instrumented in a manner similar to
Test Section No. 4 except that the internal Pt10%Rh-Pt thermocouples
are installed from both ends of the test section. This arrangement
allows a total of 8 junctions to be spaced over the active length of

the test section. Figure 29 is a photograph of the thermocouple junctions made at the end of the 11-hole insulator and installed so that the center wire (0.020 Cb-1%Zr) was in contact with the end of the insert tube plug. Figure 30 is a photograph of a junction made in a slotted insulator along the length of the insert tube. The wires and junction bead were isolated from the inner tube wall by the geometry of the insulator. Figure 31 is a photograph of the transition region between 11-hole insulator and 2-hole insulator which continue to the CATS block cold junction located inside the vacuum chamber.

The 100 KW Facility operated a total of 535 hours during the quarter including 450 hours under boiling conditions. Total operating time for this facility at the end of the quarter stands at 5897 hours.

50 KW Facility

There was no activity on this facility during the quarter. The facility was shutdown on March 5, 1965 in good operating condition at the completion of all contracted tests.

VI MATERIALS SUPPORT
W.R, Young/W.H. Kearns

During this period, two test sections were fabricated and installed in the 100 KW Cb-1Zr heat transfer facility. Test Section No. 4 contained a helix and plug insert, and Test Section No. 5 contained a wire wound plug and wire coil insert. Also, new orifices were installed upstream of the preboiler for both test sections, respectively. After Test Set No. 4 was completed, the preboiler coil was removed from the facility, and the piping at the orifice location was replaced. The preboiler was reinstalled in the facility with Test Section No. 5.

All welding, except facility installations, was done in a vacuum-purged welding chamber using the tungsten arc process. The chamber was evacuated to less than 1×10^{-4} torr and filled with high purity helium for the welding operations, Facility installations were made using previously developed, tungsten arc field welding procedures. All structural weld joints were radiographed and helium leak checked for soundness,

Fabrication of Test Section No. 4

This test section is shown in Figure 32. The boiler and exit tubes were 3/4-inch, Schedule 80 pipe. Test section piping was increased to 1-inch, Schedule 80 size downstream of the boiler tube to facilitate insert installation, The insert was supported at the end of the 1-inch pipe section. Access for internal insert thermocouples was provided through an opening at the end of the insert support. The test section shell was fabricated and inspected prior to installation of the boiler insert.

The insert, Figure 33 was composed of a straight plug section and a helical swirl. The inlet plug was 0.58-inch O.D. by 0.43-inch I.D. by 15-inches long, Overall length of the total insert was 50.4 inches. The helical swirl was 15 inches long with a 1.5-inch pitch on a 0.25-inch diameter center body tube.

A cap was welded to the plug tube, and centering bosses of weld metal were deposited at each end. The faces of the bosses were machined concentric with the plug to center it in the 3/4-inch boiler tube. This plug was subsequently welded to the reducer on the helical swirl as shown in Figure 33.

The helix (Figs. 34, 35) was made from nine washers cut radially. Initially, two spirals were made by welding washers end to end, four in one and five in the other. Both spirals were pulled axially to form helices. The helices were than slipped onto the 0.25-inch O.D. center tube, welded end to end, and tack welded to the tube. Reducers were welded to each end of the tube and centering wires were tack-welded to the unsupported tube section.

A 3/8-inch, Schedule 80 pipe provided rigid support for the insert (Figure 33). Weld metal deposits on this pipe were machined to produce a flange and three centering pads. This flange was machined to match the 1-inch, Schedule 80 pipe of the test section. The insert support was welded to a reducer on the helical swirl to complete the insert. A 3/8-inch diameter vent tube was also welded in position for evacuation of the hollow portion of the insert.

After the insert was placed in position, the final seal weld was made between the insert flange and the test section shell. Instrumentation thermocouples were then inserted, and the test section was positioned in the facility, Standard field welding

procedures were used to join the test section to the condenser and preboiler.

The 0.063-inch orifice used during Test Set No. 3 was removed from upstream of the preboiler and replaced with a 0.101-inch orifice by field welding. This weld was heat treated locally because it operates below the required average annealing temperature. It was heated at 2100°F for 1-hour using a small tungsten element furnace in the environmental vacuum chamber. The test section and installation field welds were heat treated at 2100°F by the potassium working fluid during the calibration runs.

Fabrication of Test Section No. 5

The completed test section with a boiling nucleator at the inlet is shown in Figure 37. Part of Test Section No. 4 was used for this test section. Test No. 4 boiler tube was cut off at the shell reducer leaving the insert in the pipe. The insert support section was removed by cutting through the 1-inch, Schedule 80 pipe 1.5 inches from the end. A new piece of 3/4-inch pipe was used for Test Section No. 5 boiler tube.

Two instrumented inserts were used in this test section, one installed in the exit and one in the inlet of the boiler. The test section components are shown in Figure 38.

The inlet insert was composed of a wire-wound plug followed by a helical wire coil. The plug insert at the inlet was 0.58-inch O.D. by 15.75-inches long with a 0.02-inch deep, 1.5-inch pitch helical groove machined into it to provide a seat for a wire coil. The wire coil was made of 0.094-inch diameter wire, formed to fit

tightly against the inner pipe wall, with a 1.5-inch pitch and extending the full length of the boiler section. The top half of the boiler section contained only the wire coil insert.

The boiler inlet piping included an offset formed by two special offset reducers welded back-to-back. The plug was supported on and connected to one reducer using a 0.25-inch diameter tube (Figure 38). Thermocouple instrumentation was inserted into the plug through a hole in the reducer.

The helical wire coil and the plug were inserted into the boiler tube. Downstream of the plug, the wire was attached to the tube at 2.25-inch intervals, by welding through holes in the tube, and also at the end of the tube. Subsequent X-ray inspection showed that the wire melted in two at the weld, adjacent to the plug tip. The gap in the wire, which was only about 0.16-inch, was not considered deleterious to the test. The reducers were welded together and were welded to the pipe. A boiling nucleator, Figure 39, was welded to the bottom reducer.

A thermocouple insert at the boiler exit was a piece of 0.25-inch diameter tubing seal-welded at one end with centering wires attached (Figure 38). The boiler tube was welded to the reused downstream section from Test Section 4, with the exit insert in position. The final closure weld was made in the 1-inch pipe downstream of the boiler tube.

Several orifices had been welded into the facility upstream of the preboiler coil using standard field welding procedures. Because some contamination of Cb-1Zr alloy is likely during each welding cycle, it

was decided to remove this section of piping and to replace it. Because there was no suitable location for field welding Test Section No. 5 in the facility downstream of the preboiler the preboiler coil was removed from the facility. A new section containing a thermocouple well, an orifice, and a pressure tap was fabricated. A Cb-1Zr-to- stainless steel pressure tap from the old section was used in this section. This new section was then welded to the preboiler coil in the welding chamber.

The preboiler coil and the new test section were welded together in the welding chamber. After installation of thermocouple instrumentation, the test section was field welded to the facility condenser inlet and at the preboiler inlet. The field weld and orifice section at the preboiler inlet were postweld heat treated at 1950°F for 4 hours as described previously. The test section and field weld at the condenser inlet will be heat treated during the calibration run.

VII   ANALYSIS

G.L. Converse

The analytical task during the current quarterly period
has been directed primarily toward the area of forced convective
boiling heat transfer. The specific area of interest is defined
by the following conditions:

A.   Vertical, axially symmetric flow in a constant area
      tube with a uniform heat flux imposed on the tube
      boundary.

B.   Steady flow.

C.   Two-phase single-component flow of potassium with net
      vapor generation.

D.   Flow regime of the annular or annular-mist type.

E.   Heat fluxes less than the critical heat flux.

Some preliminary results of this investigation were given in
Section VIII of Reference 12. In this reference two possible me-
chanisms of vapor generation* in the annular or annular mist flow
regimes were discussed, i.e., vapor generation by bubble formation
(nucleate boiling) and/or by evaporation at the liquid vapor
interfaces. These discussions included proposed methods for
predicting the heat transfer coefficients for either mechanism
of vapor generation. In the present section, the methods for
predicting the heat transfer coefficients which were proposed
in Reference 12 will first be reviewed, and some modifications
and limitations to the methods will be pointed out. Some of the

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* The terms vaporization or vapor generation will be used to designate
  the production of vapors by either one or a combination of the
  following mechanism:
    a.   Evaporation from the liquid-vapor interface
    b.   Vapor production by bubble formation at the heat-
          transfer surface (boiling or ebullition).

factors which determine the mechanisms of vapor generation
will then be discussed. Finally, the process of forced-
convection vaporization of potassium inside a tube with a
uniform heat flux imposed on the tube boundary will be
discussed with particular reference to data from the 100 KW
loop.

Vapor Generation by Evaporation at Existing Liquid Vapor Interfaces

For this case it was assumed that nucleate boiling was
totally suppressed, and that vapor was generated by evaporation
at existing liquid vapor interfaces.

The flow pattern was assumed to consist of a thin concentric
layer of liquid on the wall with the remainder of the liquid
entrained in the vapor core and traveling with the vapor velocity
(see sketch A below).

Vapor (Velocity, V_g)

Liquid (Velocity, V_g)

Liquid (Velocity, V_f)
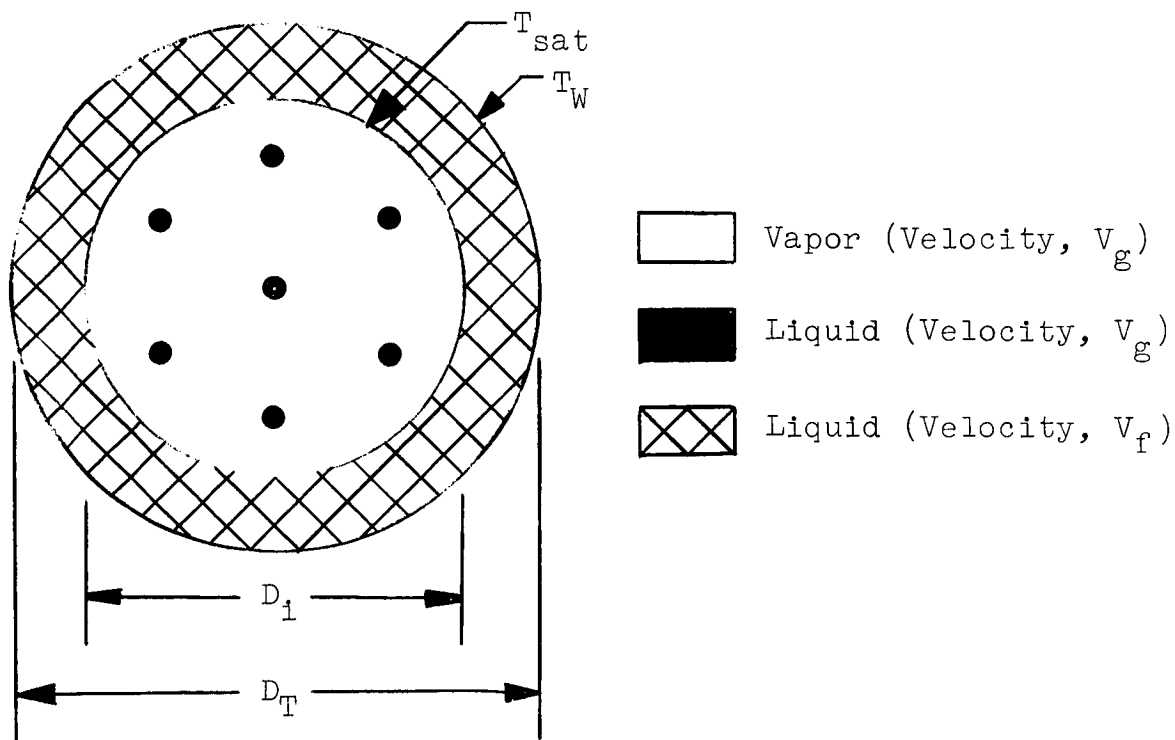
Sketch A

The mechanism of heat transfer was assumed to be conduction from the wall to the liquid vapor interface. Evaporation of the droplets was neglected. The interface was assumed to be at the local saturation temperature.

By utilizing the expression for conduction across a cylinder with a uniform heat flux imposed on the boundary, the following equation was obtained:

$$N_{Nu} = \frac{h_{FE} \, D_T}{K} = \frac{2}{\ln D_T/D_i} \tag{1}$$

Equation 1 may be rewritten in terms of the average void fraction and mass fraction of entrained liquid as follows (see Reference 12).

$$N_{Nu} = \frac{h_{FE} \, D_T}{K} = -\frac{4}{\ln \left[1 - (\frac{1-x}{x})(\frac{\rho_g}{\rho_f}) \, R_g \, (k-E) \right]} \tag{2}$$

where

$$k = (\frac{\rho_f}{\rho_g}) \quad (\frac{x}{1-x})(\frac{1-R_g}{R_g}) \tag{3}$$

In Reference 12 the behavior of Equation 2 was studied for several values of the slip ratio (k) with zero entrainment (E). In an effort to assess the effect of entrained liquid, Equation 2 was evaluated for several values of the entrainment with slip ratios of one and $(\rho_f/\rho_g)^{\frac{1}{2}}$. The resulting Nusselt numbers are shown in Figure 40. From this figure it can be seen that, within the limitations of the model chosen, the effect of entrainment is significant only for small values of the slip ratio, i.e., for slip ratios of order one.

In order to obtain an estimate of the slip ratio, the momentum exchange model (Reference 13) was used. In this model the relationship between quality and void fraction is given by the equation:

$$\frac{(1-x)^2}{(1-R_g)} + \frac{x^2}{R_g}\ \frac{\rho_f}{\rho_g} - \frac{1}{2}\frac{(1-x)^2}{(1-R_g)^2} = \frac{1}{2} \quad , \quad (4)$$

if it is assumed that $R_g \rightarrow 0$ when $x = 0$.

The void fraction quality relationship calculated from equation (4) is shown in Figure 41. This void fraction quality relationship was then used in Equation 3 in order to obtain an estimate of the slip ratio. The resulting values of the slip ratio are shown in Figure 42. From Figure 42 it can be seen that, except in the low quality region, the slip ratio is quite large for range of saturation temperatures considered. In view of the above results, it was decided to use the momentum exchange model to predict the slip ratios and void fractions to be utilized in Equation 2, and to assume that the entrainment was zero. The Nusselt numbers calculated from Equation 2 utilizing the above assumptions are shown in Figure 43.

In the derivation of Equation 2, the heat was assumed to flow along a straight radial path from the tube wall to the liquid-vapor interface, i.e., the curvature of the interface in the axial direction was neglected.

In general $\quad \dfrac{d\delta}{d\ell} = \dfrac{d(\delta/D)}{dx}\ \dfrac{dx}{d(\ell/D)} = \dfrac{4\ q''}{G\ h_{fg}}\ \dfrac{d(\delta/D)}{dx} \quad (5)$

Figure 44 is a plot of the ratio of film thickness to tube radius

against quality obtained from the void fraction plot in Figure 41 by assuming that all the liquid is on the tube wall. From Equation 5 it can be seen that the assumption of small interfacial curvature in the axial direction is poor in regions where either d $(\delta /D)/dx$ or $\frac{4q''}{Gh_{fg}}$ is large. In particular, the assumption is very poor in the low quality region, i.e., beyond the knee of the void fraction or liquid film thickness curves. In this region the Nusselt numbers shown in Figure 43 drop below the single-phase values and the solution is no longer valid. In order to remove the most undesirable feature of Figure 43, i.e., the fact that the Nusselt number drops below the single phase value in the low quality region, an interpolation formula of the form

$$\frac{h_{TP} D_T}{K} = \left[(\frac{h_{\ell} D_T}{K})^n + (\frac{h_{FE} D_T}{K})^n \right]^{1/n} \tag{6}$$

was used. The Nusselt numbers calculated from this formula will approach the single phase values at low qualities and the film evaporation values at high qualities. This procedure was used in the construction of Figure 45; a single phase Nusselt number of seven was employed together with n = 2.

Although the above procedure removes the most undesirable feature of Figure 43, it in no way adequately accounts for the surface curvature in the axial direction. However, in view of the fact that the parameter $4 q''/G h_{fg}$ is generally much less than one for potassium, it is felt that the proposed film evaporation model is adequate over most of the quality range. In the low quality region, however, both the single phase and two-phase heat transfer coefficients probably deviate somewhat from the values predicted by Equation 6.

The following qualitative trends in the two phase Nusselt number resulting from the assumption of an evaporative mechanism of vapor generation should be noted.

a) N_{Nu} increases with increasing quality for a given saturation temperature.

b) N_{Nu} increases with increasing liquid Peclet number (this follows from equations six and seven).

c) N_{Nu} increases with increasing liquid entrainment in the vapor core.

d) N_{Nu} decreases with increasing saturation temperature for a given quality.

e) N_{Nu} is independent of heat flux for the particular analytical model chosen. However, the parameter $\dfrac{4q''}{G\,h_{fg}}$ would probably be important if a more sophisticated analytical approach were used. This would be particularly true in the low quality region (i.e., beyond the knee of the void fraction quality curve).

f) h_{FE} increases with decreasing tube diameter if the remaining variables are held constant.

Vapor Generation by Vigorous Nucleate Boiling

For this case it was assumed that vapor generation by evaporation at the liquid vapor interfaces was negligible. Vapor was assumed to be generated by the formation of vapor bubbles

at the wall of the tube, and the subsequent growth and transport of these bubbles into the vapor core.

The heat transfer coefficient was assumed to consist of that obtained by the superposition of the single phase liquid forced convective heat transfer coefficient and the nucleate pool boiling heat transfer coefficient (Reference 14).

The single phase forced convective heat transfer coefficient was calculated from the equation (Reference 15).

$$N_{Nu} = 7 + 0.025 \ (N_{Pe})^{0.8} \qquad (7)$$

The nucleate pool boiling heat transfer coefficient was obtained from Equation 8 below as given by Bonilla in Reference 16.

$$T_W - T_{sat} = 49.8 \ (q'')^{0.0867} \ P^{-0.276} \qquad (8)$$

Where T is in ^{o}F, q'' in Btu/Hr-Ft^2, and P in millimeters of mercury absolute (torrs).

The heat transfer coefficients obtained from Equations 7 and 8 were then combined using the interpolation formula suggested by Kutateladze (Reference 14), i.e.,

$$\frac{h_{NB}}{h_\ell} = \sqrt{1 + (\frac{h_{PB}}{h_\ell})^2} \qquad (9)$$

The results of this calculation for a 3/4-inch I.D. tube are shown in Figure 46. It was assumed in the construction of Figure 46 that the single phase Nusselt number was equal to seven, i.e., that the mass velocity was small.

Equation 8 is based on the pool boiling data of Bonillia (Reference 17). The data was obtained by boiling potassium on a horizontal nickel plate. The approximate range of the data is given below.

P(psia)	$T_{sat}(^{\circ}F)$	q" Btu/Hr-Ft^2
0.0387 to 0.2322	690 to 840	up to 10^5
13.55 to 29.1	1380 to 1540	up to 10^5

Since both the surface conditions and the range of operating pressures in the current 100 KW facility are different from those in the pool boiling test, precise agreement between the predicted forced convective boiling heat transfer coefficient using this data and those obtained from the 100 KW Facility cannot be expected.

The following qualitative trends in the two-phase heat transfer coefficients result from the assumption of a boiling mechanism of vapor generation.

a) h_{NB} is independent of quality (for all saturation temperatures)

b) h_{NB} increases with increasing heat flux at a given saturation temperature.

c) h_{NB} increases with increased saturation temperature (increased pressure) at a given heat flux.

d) h_{NB} increases with increasing values of the single phase liquid heat transfer coefficient.

e) h_{PB} is independent of tube diameter.

It should also be noted that while it is possible to have total suppression of nucleation (i.e., heat transfer by film evaporation only); it is not possible to have boiling without some evaporation taking place. To the extent that film evaporation takes place, the effects mentioned in the preceding section will also be present during boiling.

Suppression of Nucleation

The question as to which of the two preceding mechanisms of vapor generation will take place in a given situation will now be examined with the help of a model presented by Bergles and Rohsenow (Reference 18). In Reference 18 a graphical procedure was proposed which could be used to predict the conditions necessary for boiling inception.

The graphical procedure can best be understood by referring to Sketch B below:
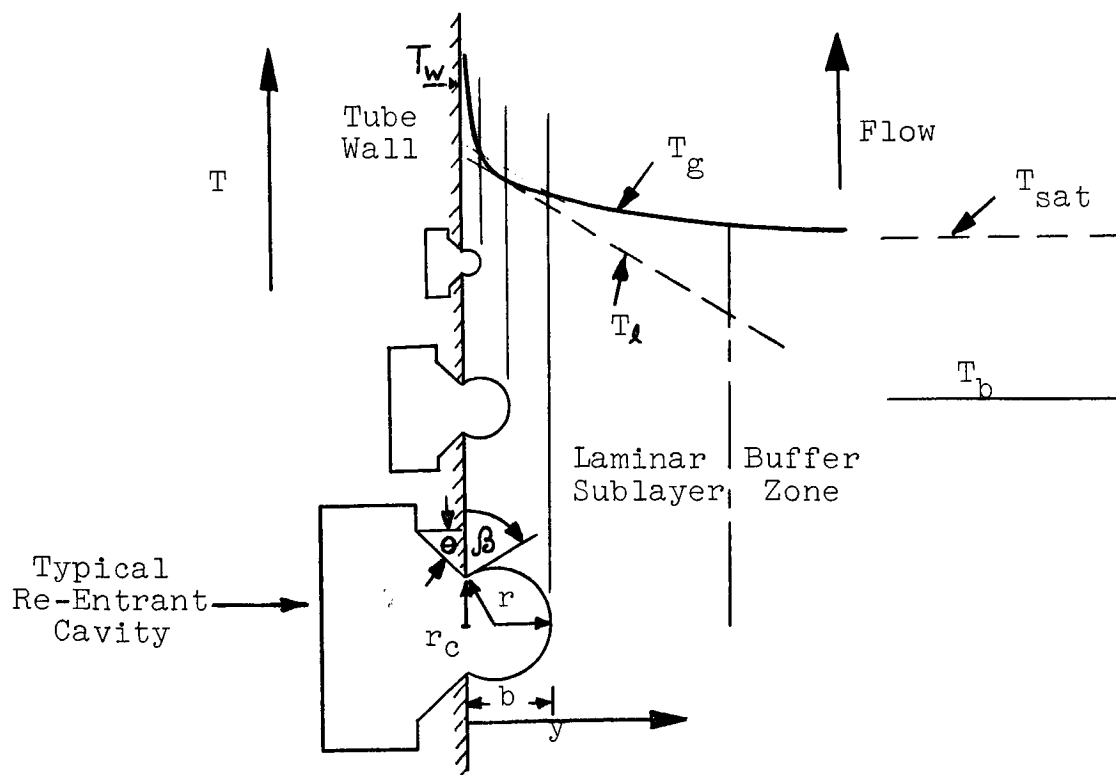
Sketch B

The condition for bubble growth given in Reference 18 is that $T_\ell \gtreqqless T_g$ for all values of $y \lesseqqgtr b$. For the limiting case of boiling inception, the following conditions apply.

(a) $T_\ell = T_g$ at $y = b$

(b) $\dfrac{dT_\ell}{dy} = \dfrac{dT_g}{db}$ at $y = b$

The liquid temperature near the wall is assumed to be linear and is determined from the equation:

$$T_\ell = T_w - q'' \frac{y}{K} \qquad (10)$$

The temperature inside the vapor bubble is approximately the saturation temperature corresponding to the pressure inside the vapor bubble as given by the Helmholtz relations for the radius of curvature, i.e.,

$$P_g - P_\ell = \frac{2\delta}{r} \qquad (11)$$

The relationships between the height of the bubble (b), the bubble radius (r), and the cavity mouth radius (r_c) are given by the following equations(obtained from Sketch B).

$$b = (1 + \cos\beta)\, r \qquad (12)$$
$$r \sin\beta = r_c \qquad (13)$$

where $0° < \beta \leq 90°$

It might have been well to omit the consideration of contact angle in the following derivation since in general the relationships between cavity mouth radius, bubble height, and bubble radius at

boiling inception cannot be written down independent of the cavity shape. Since potassium is generally assumed to be a highly wetting fluid (i.e., small contact angle), it was assumed that all the non-re-entrant or conical type cavities would be "snuffed out" and that only those cavities which were not flooded by subcooled liquid (i.e., re-entrant cavities) would trap vapor. (Reference 19 contains a good discussion of re-entrant and conical type cavities). For the particular cavity shape shown in Sketch B, if it is assumed that $\theta + \beta > 90^{\circ}$ then the conditions of equilibrium at the liquid vapor interface will require that the liquid be subcooled if the interface is within the cavity. Under these conditions the liquid vapor interface will retreat to the inside lip of the cavity as soon as some wall superheat is available, it will then, somehow, round the corner and hang on the outer lip of the cavity in the condition of equilibrium shown in Sketch B until boiling inception occurs. If it had been assumed that $\theta + \beta < 90^{\circ}$ then the liquid would have been superheated within the cavity. The superheat required for boiling inception could then have been dependent on the cavity angle θ . Since it was desired to include (in at least an approximate fashion) the effect of contact angle but not the effect of cavity angle, the above cavity configuration was chosen. In reality the solution to the boiling inception problems probably requires the solution to the fluid flow and heat transfer problem associated with the expansion of the initial volume of trapped vapor to the final state of boiling inception.

In Reference 18, the bubbles were assumed to be hemispherical ($b = r = r_c$) and the above equations were solved graphically to obtain a boiling inception curve, i.e., the relationship between the heat flux and wall superheat at boiling inception. The actual

point of boiling inception is then determined by obtaining
the point of intersection of the boiling inception curve with
the usual single phase forced-convection or natural-convection
heat transfer relationship between q" and T_w for a particular
value of bulk fluid temperature.

Since the graphical procedure is somewhat tedious, an
approximate solution to the above equations was obtained in
the following manner. Assume that the vapor-temperature inside
the bubble can be satisfactorily approximated for small super-
heats by the equation (Reference 20),

$$T_g = T_{sat} + \frac{2\sigma \ T_{sat} \ v_{fg}}{Jh_{fg} \ r} \qquad (14)$$

where T_{sat} is the saturation temperature corresponding to the
external liquid pressure. Equations 10, 12, 13 and 14 are then
solved simultaneously to determine the relationship between
q" and $T_w - T_{sat}$ which will satisfy conditions (a) and (b) above.
The resulting expression is of the form:

$$q_i'' = \frac{Jh_{fg} \ K}{8\sigma \ (1 + \cos \beta)} \frac{(T_w - T_{sat})^2}{T_{sat} \ v_{fg}} \qquad (15)$$

The critical cavity size (the cavity size that nucleates
first) is given by the expression:

$$r_c = \frac{4\sigma \ v_{fg} \ T_{sat} \ \sin \beta}{Jh_{fg}(T_w - T_{sat})} \qquad (16)$$

The accuracy of Equation 15 may be judged by referring to
Figure 47, in which several graphical solutions have been compared
with Equation 15. In each case it was assumed that $\beta = 90^\circ$

(i.e. $b = r = r_c$). The graphical solution for water is given
in Reference 18, while that for Freon 113 was obtained from
Reference 21. Preliminary comparison of Equation 15 with a
graphical solution for potassium are also shown in Figure 47.

Equations 15 and 16 were used to generate the curves shown
in Figure 48 for potassium. The wall superheat required for
boiling inception at a given heat flux is shown as well as the
critical cavity size. Equation 15 applies when an infinite range
of cavity sizes are available on the heat transfer surface. If
a maximum cavity size exist then

$$(T_w - T_{sat}) = \frac{2\sigma \, T_{sat} \, v_{fg} \, \sin\beta}{J h_{fg} \, r_{max}} + \frac{q''}{K} \left(\frac{1 + \cos\beta}{\sin\beta} \right) r_{max} \qquad (17)$$

where r_{max} is the maximum cavity size on the heat transfer surface.
(The contact angle was assumed to be 90° in all calculations. It
is recognized that this is probably a poor assumption for potassium.
However, until contact angle data on potassium becomes available,
and until the role of the contact angle in nucleation is somewhat
better understood it was felt that the inclusion of this additional
parameter in the ensuing calculations was not justified. The
assumption of hemispherical bubbles has met with some success in
the prediction of the boiling inception points for water (Reference 18)
although the contact angle of water is known to differ from 90°.

If it is assumed that Equation 17 correctly represents the
effect of contact angle then a reduction in the wall superheat
requirement for a given heat flux and cavity size would result.
This does not necessarily imply a reduction in the wall superheat
required for boiling inception since the "history" of the boiling
surface must also be considered. This effect will subsequently
be discussed in more detail.)

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The existence of a limited range of cavity sizes acts to increase the superheat required for boiling inception at any heat flux. This behavior is shown in Figure 49. The nearly vertical lines represent the minimum wall superheat requirement as obtained from Equation 17 for the maximum cavity size shown on the curve. The asymptotic line was obtained from Equation 15. Also shown on Figure 49 are the usual single phase forced-convection lines obtained from Lyon's Equation (Reference 15).

$$N_{Nu} = 7 + .025 \ (N_{Pe})^{.8} \hspace{2cm} (17)$$

Figure 49 illustrated the manner in which the boiling inception point is determined. If, for example, the test section heat flux is set at 20,000 Btu/Hr-Ft^2 then about 1°F of wall superheat is required for boiling inception if an infinite range of cavity sizes are available. Boiling would then commence when the bulk fluid was about 10°F subcooled. If on the other hand a maximum cavity size of 0.05 mils existed on the heat transfer surface then boiling would not begin until the bulk fluid was superheated about 30°F, i.e., due to the limited range of cavity sizes subcooled boiling would not take place at this heat flux.

Equations 15 and 17 will now be used to investigate the question of total suppression of nucleation in the region of net vapor generation. Many of the factors influencing nucleation are not clearly understood. In the following treatment it will be assumed that nucleation from the tube wall will take place if the following conditions exist.

(a) Small cavities or pits are present on the tube wall.

(b) These cavities contain entrapped vapor or gas.

(c)   The wall superheat is sufficient to activate the
      cavity, i.e., to cause the small vapor space present
      in the cavity to grow and produce bubbles.

Condition (a) is generally met by any commercial surface.
Photographs of the heat transfer surface utilized in the 100 KW
loop during the period 8/1/64 to 11/14/64 are shown in Figures
50a and 50b. The particular test section shown in these figures
was removed from the loop on 11/14/64 after approximately 671
hours of operation at temperatures above 800°F. The approxi-
mate size of some of the more obvious pits or scratches have
been designated in the photographs.

Condition (b) is probably the most difficult of the three
conditions to treat adequately for alkali metals. In the 100 KW
loop, for example, the potassium used as a working fluid is quite
pure (less than 50 ppm O_2) and considerable care is taken to ex-
clude any gases from the test section. With the potassium fill
line closed, the loop piping is evacuated down to approximately
25 microns with an auxiliary vacuum pump. The vacuum line is
then closed and the loop is filled by pressurizing the dump
tank with argon. If it is assumed that inerts are excluded from
the test section, then each time subcooled liquid flows over the
heat transfer surface all of the cavities are "snuffed out" ex-
cept those of the smaller re-entrant type. This is due to the
fact that potassium wets the surface. The net result of the
above effects is that relatively high degrees of wall superheat
would be required at the beginning of two-phase operation. Some
verification of the above hypothesis is found in the relatively
high value of wall superheat (about 200°F, at T_{sat} = 1800°F) re-
ported at the beginning of two-phase operation (see Figures 32 and
33 of Reference 7). However, additional data will be required
before any firm conclusion can be reached.

Condition (c) can be treated by using Equations 15 and 17 in conjunction with the previously derived film evaporation theory. It will be assumed that if the wall superheats calculated from the film evaporation model are sufficient to cause nucleation then nucleation will occur and the boiling mechanism will predominate. In view of the above discussion it is evident that this is a necessary but by no means sufficient conditions for boiling. However, the use of this assumption will at least permit a preliminary estimation to be made of the regions in which nucleate boiling and film evaporation will take place,

The steps necessary to construct such a map are illustrated by Figure 51. The wall superheats required are obtained from Equations 15 and 17. The maximum cavity size on the surface is taken as a parameter in the construction of these curves. The available wall superheat is then obtained from the film evaporation model using the Nusselt numbers from Figure 45. If the available superheat exceeds the required superheat it is assumed that nucleation will occur. The end results of this procedure for a 3/4-inch diameter tube are shown in Figures 52a and 52b.

In order to utilize Figure 52 some knowledge of the range of cavity sizes available on the heat transfer surface is required. For example, based on Figures 50a and 50b, a maximum cavity radius of $\sim$ 0.1 to .2 mils may be estimated for the 100 KW loop. Based on this estimate Figure 52a would predict that the mechanism of vapor generation at $q'' = 10^5$ Btu/Hr-Ft^2 and $T_{sat} = 2100^{\circ}$F would be vigorous nucleate boiling for qualities less than about 70%. For the same conditions at $T_{sat} = 1500^{\circ}$F no boiling would be predicted and the mechanism of vapor generation would be film evaporation.

It should be pointed out that Figure 52 applies only to a
3/4-inch I.D. tube. Since the film thickness increases when
the tube size is increased (see Figure 44) the likelihood of
boiling is greater for large diameter tubes and less for small
diameter tubes if all other variables are the same.

The following qualitative trends are evidenced by Figure 52 .

(a) At a given heat flux, saturation temperature, and maximum
     cavity size, nucleate boiling tends to be suppressed
     by increasing quality.

(b) At a given heat flux, saturation temperature and quality,
     nucleate boiling tends to be suppressed for smaller
     values of the maximum cavity size (i.e., for smoother
     heat transfer surfaces).

(c) At a given quality, saturation temperature, and maximum
     cavity size, nucleate boiling tends to be suppressed
     by lowering the heat flux.

(d) At a given quality, heat flux, and maximum cavity size,
     nucleate boiling tends to be suppressed by lowering
     the pressure.

The highly preliminary nature of the mapping shown in
Figure 52 should be stressed. Some of the more important sources
of error are the following:

1. Inadequacies in the method used to calculate the
    film thickness

         In this connection particular attention should be
    called to fact that in the method used an assumption was
    made that the film thickness is independent of the heat
    flux.

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2. The assumption of a smooth interface

The assumption of a smooth interface (i.e., the assumed absence of waves on the liquid vapor interface) is known to be unrealistic. In general the presence of waves on the interface will probably increase the film evaporation heat transfer coefficient. Although there are many factors which influence the wave amplitude the effect of heat flux should be particularly noted. In Reference 22 N. Zuber suggested that the thrust exerted by the vapor on the liquid vapor interface would act to destabilize the interface. Since the vapor thrust is proportional to the square of the heat flux, waves of larger amplitude might be expected at higher heat flux levels. This would have the effect of extending the film evaporation region in Figure 52 at the higher heat fluxes, i.e., the transition lines would become more vertical for the higher heat fluxes.

3. Errors in the estimate of the maximum cavity size

4. The possible effect of contact angle on the wall superheat requirement. Some indication of this effect can be obtained by comparing Figures 52a and 52b.

Any of the factors listed above could quantitatively alter Figure 52 . However, it is less probable that the qualitative trends evidenced by the map will be radically altered. It should also be pointed out that Figure 52 was constructed by assuming that the mechanism of vapor generation was film evaporation and calculating the conditions necessary for boiling to begin. In general, the location of the transition lines in Figure 52 would not be expected to be independent of the direction in which they are traversed. For this reason the map would be expected to be less reliable in predicting the point of boiling suppression th

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the point of boiling inception.

Vaporization of Potassium In A Tube Having A Uniform Heat Flux Imposed On The Tube Boundary

In this section the process of forced-convection vaporization of potassium inside a tube with a uniform heat flux imposed on the tube boundary will be discussed with the aid of data from the 100 KW loop. Before beginning the discussion, it would probably be well to point out the highly conjectural nature of much of what follows. This must necessarily be the case since in many instances data on which to base a firm conclusion is either absent or lacking in accuracy. During the course of the discussion frequent comparison will be made between the data and the previously derived analytical results. In this way the areas of agreement and disagreement can be assessed. Repeated reference to all the weaknesses in the analytical development will not be made when areas of disagreement with the data are found; only those weaknesses which appear to be the most likely cause of the discrepancy will be noted.

In Figure 53 several curves of temperature distribution along the 100 KW test section with the fluid in vertical upflow are shown. Some additional information on the runs shown in Figure 53 which is pertinent to the discussion is tabulated below:

Table A

Run Desig.	$dT_b/d(\ell/D)$	L/D To Sat.	L/D To Spike	T_b-T_{sat} At Spike(°F)	T_w-T_{sat} At Spike(°F)	Two-Phase Pressure Drop (psia) (Calculated)
O	21.3°F	25.6	27.25	35.0	65	0.1747 (ΔT_{sat} = 0.629°F)
◈	19.9°F	27.9	30.00	41.8	62	0.16877 (ΔT_{sat} = 0.608°F)
△	16.3°F	32.8	35.50	44.0	58	0.15702 (ΔT_{sat} = 0.565°F)

Note: Since the inlet well is located about 3 L/D's upstream of the heated zone, it does not give an accurate indication of the inlet

liquid temperature. Due to the small specific heat of potassium and the relatively low flow rate any heat transferred to the fluid between the well location and the start of the heated zone could considerably alter the inlet liquid temperature. For this reason a great deal of confidence cannot be placed in the calculated values of the bulk liquid temperature in the test section.

Focusing attention on the curves, two distinct regions separated by a temperature spike are observed. Near the inlet of the tube both the wall and liquid temperatures are rising at about the same rate, since both temperatures are below the saturation temperature. No vaporization is taking place and the heat is transferred by ordinary single phase forced convection. The wall temperature then increases above the saturation temperature so that subcooled boiling becomes a possibility. However, the wall temperature continues to increase at about the same rate thus indicating no significant change in heat transfer coefficient and suggesting that no subcooled boiling takes place. The point of boiling inception should be predicted by Figure 49 . If a maximum cavity size of 0.1 mils is assumed (based on Figure 50), boiling should occur according to Figure 49 when the bulk fluid is about $50^{O}F$ subcooled for the higher heat flux run. In reality the situation is not this simple. Since the testing is generally conducted by lowering the point of first vapor generation in the tube by either increasing the heat flux or decreasing the flow starting from a initially subcooled condition, the larger cavities may have been "snuffed out" as discussed in the previous section. If this is true then nucleation must occur from the smaller re-entrant cavities. If, for example, the maximum re-entrant cavity size which contains vapor is taken as 0.01 mils then from Figure 49 the bulk fluid must be about $150^{O}F$ superheated for the highest heat flux run in order to obtain the wall superheat necessary to

produce the first vapors. When this condition is present the
boiling boundary (the point of first net vapor generation in
the tube) is frequently unstable. The following is a quote
from the 100 KW Log* written at a time when the boiling boundary
was experiencing this type of instability.

Time
1445:   "Rubicon set on A-16, occasionally temperature
         variations of approximately $100°F$, A-15 is very
         slightly active, A-17 is also very active similar
         to A-16" (A-15 -16 and 17 are thermocouples).

1515:   "Reading taken"

The data taken at 1515 has been plotted in Figure 54. It
should be noted that the temperatures were read from inlet to
exit of the tube with about a 10 second delay between each
reading. The resulting wall temperature profile is, therefore,
not an instantaneous picture. The extent of the instability
associated with the runs shown in Figure 53 is not known.
However, it is felt that some instability is always associated
with the boiling boundary when the first vapors are produced
with the bulk fluid in a superheated condition. If subcooled
boiling occurs the instability is probably minimized if not
entirely absent for reasons discussed subsequently below.

A possible working hypothesis to explain this instability is
the following. When the first bubbles are produced they grow very
rapidly due to the fact that the liquid is superheated across
the entire flow area of the tube. This produces a local
pressure pulse which may increase the local wall temperature

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*100 KW Log, Vol. II, February 14, 1964, page 149

required for boiling to continue from the same size cavity
which produced the first bubble. However, as the bulk liquid
temperature drops toward saturation after the first bubble is
produced, there is also an increase in the local value of $T_w - T_b$
equal to the bulk fluid superheat. This latter effect causes
the wall temperature to decrease. Therefore, after the first
bubble is produced the system is faced with a situation
where a higher wall temperature is required to continue boiling
(due to the pressure pulse) but only a lower wall temperature is
available (due to the cooling of the wall). Under these condi-
tions the boiling action may cease unless larger cavities have
been activated by the first vapors. If larger cavities have
not become active the boiling action will cease, the vapors
produced will be swept away and the liquid will begin to super-
heat again thus repeating the cycle. Other explanations of
the instability such as a local flow oscillation are
possible. At the present time there is insufficient data to
draw any firm conclusion about the cause of the instability.

After vaporization has begun, the wall temperature in
Figure 53 decreases rapidly at first and then reaches a relatively
constant value. If the nature of the local instability at the
boiling boundary is due to intermittent boiling as suggested above,
then the mechanism of vapor generation in the low quality region
is probably one of film evaporation. Thus, inspite of the fact
that the local wall superheat is sufficient to produce boiling
from the larger cavities, no boiling takes place since these
cavities have been snuffed out. For the runs shown in Figure 53
boiling may not begin until sufficient vapor has been entrained
in the film to activate the larger cavities present on the surface
of the tube. In order for this to occur the following sequence of

events must take place.

1. Vapor must be entrained in the liquid film

2. The entrained vapor must displace the liquid from a nucleation site.

3. The "captured site" must itself be capable of serving as a site for further nucleation or as a site from which nucleation can spread to adjacent cavities.

Thus far it has been tacitly assumed that conical cavities are not sufficiently stable to serve as nucleation sites for liquid metals. However, it appears unlikely that the vapors would "capture" previously flooded re-entrant cavities, but rather the shallow conical cavities. Factors which might tend to make conical cavities stable are the high thermal conductivity and low specific heat of potassium, i.e., the liquid would heat up quite rapidly as it penetrated into the cavity. This might offset the effect of small contact angle. Obviously a dynamic analysis of cavity stability would be required to answer this question.

For the reasons given above the heat transfer coefficients in Figure 53 would be expected to increase with quality in accordance with the film evaporation theory until the larger cavities become active. At this point there should be a rather sudden increase in the heat transfer coefficient to about the pool boiling value, and very little change thereafter. Some confirmation of the suppression of nucleation in the low quality region downstream of the boiling boundary in Figure 53 is inferred from Figures 55a thru 55d, although the heat fluxes are somewhat lower than those of Figure 53.

In these runs some net quality was present of the inlet of the test section and, although the qualities were quite low, the heat transfer coefficients obtained were at or about the pool boiling value and showed little variation with quality.

In the preceding discussion some of the features which must be considered in connection with the vaporization of potassium in a plain tube have been presented. The phenomenon is complicated by the fact that, in the choice of a mechanism of vapor generation, the previous history of the boiling surface must be considered in addition to the wall superheat requirement as discussed in connection with Figure 52 .

The Nusselt numbers calculated from the data shown in Figure 53 have been compared with the values predicted by the film evaporation model. This comparison is shown in Figure 56 . The comparison at low qualities is a severe test of the film evaporation model, since it is in this region where the effects of both liquid entrainment and axial curvature of the interface would be expected to be the greatest. The latter effect was shown to be related to the parameter $\frac{4q''}{Gh_{fg}}$. This parameter was calculated for the curves of Figure 56 . In general the Nusselt number shows an increase with increasing values of this parameter. It is felt that a film evaporation theory which included the two effects mentioned above could adequately predict the Nusselt numbers in the low quality region. From a design standpoint the present model may provide a conservative estimate of the heat transfer coefficients in this region.

In Figures 57 thru 59 the relationship between heat flux and temperature difference has been plotted from data taken at the

tube exit, i.e., in a region well removed from the boiling boundary. From Figure 52 it can be estimated that for a 0.2 to 0.1 mil maximum cavity size all the data shown in Figure 57 (T_{sat} = 2100°F) should be boiling with the exception of the 2 points which fall to the right of the pool boiling line. The lack of any consistent detectable quality trend in the data (plots of the same data on h vs. x coordinate can be found in Figure 15c of Reference 7) together with the apparent heat flux effect tend to confirm the boiling mechanism. The two points which fall to the right of the pool boiling line should be remarked upon. The higher heat flux point is probably a DNB point. The lower heat flux point may also be a DNB point but this is less probable. This point will be discussed in more detail in connection with Figure 58.

From Figure 52a it can be estimated that for a .2 mil maximum cavity size no boiling should occur for qualities above about 40% at 1990°F and for a .1 mil maximum cavity size no boiling should occur above about 60% quality. However, both Figures 58 and 59 indicate that boiling persists at the lowest heat flux (q" $\simeq$ 30,000 Btu/Hr-Ft^2) to quite high values of the quality. Further confirmation of the boiling mechanism at low heat fluxes is obtained from Figures 60a and 60b. From these Figures it can be seen that there is little or no variation in heat transfer coefficient with quality along the tube length. This strongly suggest that the tube is in nucleate boiling. The persistence of the boiling mechanism at the lower heat fluxes may be due to the fact that once boiling begins in the tube the presence of the bubbles in the film may alter the film thickness and temperature distribution in the film itself. If this takes place the tube might "hang" in boiling somewhat longer than would be expected. The assumption of a contact angle of 90° could also be the source of the discrepancy (the effect of contact angle on the map can be assessed by referring to Figure 52b). Whatever the reason,

the data definitely indicates that boiling persists up to about 35% quality at 1750°F. This is not true, however, of the higher heat flux data of Figure 58. At the higher heat fluxes the predicted boiling points fall to the right in the plot as would be expected. The remaining points trail off to the left but do not appear to line up along constant quality lines as would be predicted by the film evaporation model (the same data on h vs. x coordinates can be found in Figure 15b of Reference 7). This may be due simply to errors in the measurement of $T_w - T_{sat}$ for these small values of ΔT.

The data shown on Figure 58, therefore, pose the following questions:

1. Nucleate boiling appears to be present at the lowest heat flux for qualities up to about 72%. How then can boiling be suppressed at the higher heat fluxes at lower values of quality for which the thicker film would be expected to cause an even larger value of the wall superheat?

2. If boiling is suppressed at the higher heat fluxes why doesn't the data fall along constant quality lines as would be predicted by the film evaporation theory?

These questions will be examined in reverse order   The second question will be examined first by means of the error analysis which follows.

In an effort to ascertain if the lack of agreement between the data and the film evaporation model evidenced in Figure 58 could in part be attributed to experimental error in the measurement of small temperature differences, an error analysis

was carried out. The following sources of error were considered.

    a)   Random errors in temperature measurement
           (as evidenced by multiple digital printouts
           of the temperature at a given station)

    b)   Errors due to thermocouple drift
           (as evidenced by a change in the relative
           thermocouple calibrations before and after
           testing)

    c)   Errors in the calculation of inside wall
           temperature due to the uncertainty in wall
           conductivity. (Taken as $\pm$ 4% probable error
           based on the results of Reference 23)

    d)   Errors in heat flux (Estimated as $\pm$ 3%
           probable error)

The details of the analysis are given in Appendix E. Two cases were considered. In the first case two wall thermocouples were analyzed, this is representative of the measuring station at the exit of the tube. In the second case only a single wall thermocouple was analyzed, this is representative of the remaining measuring stations along the length of the test section. The results are summarized in the table below.

q'' Btu/Hr-Ft^2	$P_{[TWI - Tf]}$ (^{O}F) (1 wall - 3 well)	$P_{[TWI - Tf]}$ (^{O}F) (2 wall - 3 well)
0	1.038^{O}F	0.74753^{O}F
2.5 x 10^4	1.1676^{O}F	0.91897^{O}F
5 x 10^4	1.4900^{O}F	1.3045 ^{O}F
7.5 x 10^4	1.9102^{O}F	1.7692 ^{O}F
1 x 10^5	2.3767^{O}F	2.2649 ^{O}F
1.25x 10^5	2.8671^{O}F	2.7751 ^{O}F
1.5 x 10^5	3.3709^{O}F	3.2930 ^{O}F

These results can be conveniently represented in terms
of percent probable error in ΔT. This type of representation
is shown in Figures 61a and 61b for the two cases considered.
Note that the percentage error increases rapidly as ΔT decreases
or as the heat flux increases. The lack of agreement between
the film evaporation model and the data evidenced at the higher
heat fluxes in Figure 58 is easily explained in terms of the
probable error. However, the low heat flux data cannot be
easily explained in this fashion since the probable error is
only about $\pm$ 20%. Therefore the error analysis tends to
support the conclusion that boiling is present in the tube
at the lower heat flux. The first question will now be examined.
In discussing the limitations of the mapping shown in Figure 52
attention was called to the effect of heat flux both on the
mean film thickness and on the amplitude of the interfacial
waves. The presence of waves of relatively large amplitude at
the higher heat fluxes might increase the film evaporation heat
transfer coefficient sufficiently so that the wall superheat

developed could no longer support boiling at the higher heat
fluxes. Note that it is being assumed that boiling is
suppressed to some extent in Figure 59 as evidenced by the
tendency of the points to trail off to the left. This could
be due to an error in wall thermal conductivity or heat flux
as indicated by the error analysis. If this were the case,
however, it is difficult to see why the data in Figure 58 would
not show a similar trend. The solution proposed above is not
entirely satisfactory since the heat transfer coefficient would
be expected to be higher than those obtained from the film
evaporation theory, whereas, in actual fact, they are somewhat
lower. If the above hypothesis is accepted this latter discrepancy
must be attributed to experimental error. Another possible solution
investigated was the effect of aging on the tube surface, i.e.,
the heat transfer surface might become smoother with time. However,
little correlation with time could be found in the data shown
in Figure 59.

The percentage probable error in ΔT is approximately equal
to the percentage probable error in heat transfer coefficient
(equal to it if the relatively small percentage error due to
heat flux is neglected). Figures 62a thru 62e show some of the
runs used in the construction of Figure 59 . If these runs are
considered together with those shown in Figures 60a and 60b the
increase in the scatter in heat transfer coefficient with increasing
heat flux is evident. Although there appears to be a general trend
toward increasing heat transfer coefficient with increasing heat
flux over roughly the same quality range, the data is too scattered
to form any conclusion as to the mechanism of vapor generation
except at the lower heat fluxes.

Conclusions

Based on the preceding discussion the following tentative conclusions may be drawn.

1. If boiling occurs in the tube, the forced-convection nucleate boiling heat transfer coefficients predicted by equation 9 appear to be somewhat conservative.

2. If vapor is generated by film evaporation, the two-phase heat transfer coefficients predicted by Equation 6 appear to be somewhat conservative in the low quality region (probably due to the neglect of liquid entrainment and axial curvature of the interface in the model chosen) but may over estimate the heat transfer coefficient in the high quality region.

3. The map presented in Figure 52 is useful in making a preliminary judgement as to the predominate mechanism of vapor generation in the tube if operation occurs entirely in a region well removed from the transition lines. However, the map does not predict the location of the transition lines with any great degree of accuracy.

4. The "history" of the boiling surface may be an important factor in determining the mechanism of vapor generation as well as in boiling inception.

For the range of the tube diameters, heat fluxes, operating pressures, and mass velocities currently being considered for boiler design; the two-phase heat transfer coefficient will be high at heat fluxes less than the critical (high relative to the single phase and transition boiling heat transfer coefficients)

regardless of the mechanism of vapor generation. For this
reason an accurate method for predicting the mechanism of
vapor generation is not required at the present time. It
is important, however, to recognize that different mechanism
of vapor generation may occur in the tube, since this could aid in
the correlation and extrapolation of the data. For the reasons
given above, it is felt that the present treatment is probably
adequate for design purposes and a recommended design procedure
for calculating two-phase heat transfer coefficient will be
given below. Additional work is required, however, on the
boiling inception problem and on the local instability associated
with the boiling boundary. This work may aid in understanding
the role played by the previous history of the boiling surface.

Recommended Design Procedure for Calculating Heat Transfer Co-efficients at Heat Fluxes Less Than The Critical

The recommended design procedure is the following:

1. Utilizing Figure 43 together with Equation 6 calculate
   the film evaporation heat transfer coefficient.

2. Utilize equations 7, 8 and 9 to calculate the
   forced convection nucleate boiling heat transfer
   coefficients.

3. Utilizing a map similar to that shown in Figure 52
   determine the mechanism of vapor generation.

4. Use the heat transfer coefficient applicable to the
   particular mode of vaporization expected. If additional
   conservatism is desired use the smaller of the two values
   irrespective of the regime.

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TABLE 1

CRITICAL HEAT FLUX AND TRANSITION BOILING DATA FROM 300 KW PROJECT

3/4-inch Nominal Diameter Tube with P/D = 6 Helical Insert (0.67-inch I.D.)

Date 1964	Time	G_K	T_{K_c} °F	$T_{K_{TB}}$ °F	X_c	X_{TB}	q''_c	h_{TB}	q''_{TB}	$\bar{\Delta T}_{TB}$	$\sqrt[4]{a}$
10/10	2150	38.6	1686.2	1669.6	.758	.879	298,900	842	97,200	115	2.84
10/11	0230	40.5	1686.7	1664.2	.736	.868	395,000	743	101,000	136	2.87
10/12	0800	34.1	1603.7	1582.4	.759	.880	261,400	1215	129,800	107	2.88
10/12	1200	38.1	1615.2	1576.4	.801	.901	287,100	678	94,400	139	3.09
10/12	1220	38.0	1618.6	1590.7	.731	.866	302,600	1326	138,600	104	2.94
10/12	1240	37.0	1615.7	1587.1	.709	.855	277,500	1690	161,800	96	2.86
10/17	0400	44.7	1655.0	1621.1	.696	.848	446,200	989	152,200	154	3.01

3/4-inch Nominal Diameter Tube with No Insert, Counter Flow (0.67-inch I.D.)

Date 1964	Time	G_K	T_{K_c} °F	$T_{K_{TB}}$ °F	X_c	X_{TB}	q''_c	h_{TB}	q''_{TB}	$\bar{\Delta T}_{TB}$	$\sqrt[4]{a}$
10/29	1130	31.7	1694.8	1691.1	.533	.648	187,000	1736	100,250	58	1.0
10/30	1330	36.0	1688.9	1685.3	.602	.659	193,200	1612	105,600	66	1.0
10/31	0300	50.6	1690.9	1685.4	.540	.617	269,800	2136	159,700	75	1.0
11/1	0030	31.7	1556.3	1550.0	.670	.745	221,950	1259	98,200	78	1.0
11/1	1730	38.0	1569.4	1551.9	.562	.652	427,000	385	59,700	155	1.0
11/1	2100	32.5	1576.6	1566.2	.556	.641	275,900	565	55,700	98.5	1.0
11/1	2330	31.7	1562.0	1551.0	.557	.683	341,700	612	68,800	112	1.0
11/2	0100	32.4	1555.5	1545.4	.548	.671	244,900	884	93,700	106	1.0
11/2	0230	32.1	1553.4	1543.0	.632	.713	280,700	471	66,800	142	1.0
11/14	1830	47.9	1702.7	1695.0	.505	.616	274,100	1695	151,900	90	1.0
11/15	2100	73.0	1597.2	1570.6	.486	.532	355,100	1952	234,100	120	1.0
11/16	0700	100.6	1643.2	1600.6	.398	.444	428,600	2394	304,600	127	1.0
11/17	0215	32.6	1566.8	1563.9	.708	.736	221,000	1034	101,200	98	1.0
11/17	0345	32.6	1558.9	1547.7	.607	.693	370,600	292	52,000	178	1.0
11/17	0900	49.3	1563.0	1557.5	.549	.576	295,000	474	74,800	158	1.0
11/17	0905	49.3	1554.1	1539.6	.524	.586	360,800	462	84,400	183	1.0
11/18	0215	33.3	1705.0	1703.5	.617	.688	191,100	2305	144,500	63	1.0
11/18	1000	50.8	1630.7	1618.4	.500	.591	377,700	608	104,500	172	1.0

TABLE 1   (Continued)

CRITICAL HEAT FLUX AND TRANSITION BOILING
DATA FROM 300 KW PROJECT

3/4-inch Nominal Diameter Tube with No Insert, Cocurrent Flow

Date 1964	Time	G_K	T_{K_c} °F	$T_{K_{TB}}$ °F	X_c	X_{TB}	q_c''	h_{TB}	q_{TB}''	$\overline{\Delta T_{TB}}$	$\sqrt[4]{a}$
11/5	0930	29.9	1573.4	1557.2	.686	.784	178,600	1428	89,600	63	1.0
11/5	1030	35.6	1558.5	1540.0	.559	.661	200,300	1115	94,300	85	1.0
11/6	0515	32.8	1677.1	1673.7	.703	.800	210,400	750	82,100	109	1.0
11/7	1130	49.8	1703.5	1697.9	.687	.731	219,600	1957	129,950	66	1.0
11/8	0530	34.4	1563.5	1545.2	.597	.749	269,400	749	102,600	137	1.0
11/10	0100	48.8	1584.1	1559.1	.585	.673	287,500	849	115,700	136	1.0
11/12	0300	52.5	1583.1	1559.9	.576	.647	235,300	2183	181,800	83	1.0

Table 2   Critical Heat Flux Data From 100 KW Project

Date	Recorder Chart	Test Section I.D. Inch	Insert	T_{sat} °F	G lb/sec-ft²	q''_c Btu/Hr-Ft²	x_c %	L/D	Symbols Used In Figures 16,17,18	$\sqrt[4]{a}$
10/22/64	CHF1C	0.767	None	2100	15.5	152,000	67	36.5	O	1.0
10/22/64	CHF2	0.767	None	2100	16	151,000	65	36.5	O	1.0
10/22/64	CHF3B	0.767	None	2100	15.5	152,000	66	36.5	O	1.0
10/23/64	CHF4	0.767	None	2100	22	129,000	91	36.5	△	1.0
	CHF5	0.740	P/D = 6	2100	22	150,000	93	37.8		1.76
	CHF6	0.740	P/D = 6	2100	16	150,000	84	37.8		1.42
2/27/65	CHF7	0.423	None	2105	61.6	157,000	81	66.3	◆	1.0
2/28/65	CHF8	0.423	None	2102	61.7	224,000	74	66.3	◆	1.0
3/17/65	CHF9	0.423	None	2100	31	101,000	66	66.3	■	1.0
3/27/65	CHF10	0.423	None	1838	41.2	171,000	57	66.3	X	1.0
3/31/65	CHF11A	0.423	None	2104	47.6	95,000	88	66.3	◀	1.0
	CHF11B	0.423	None	2104	47.6	94,000	85	35.5	◀	1.0
3/31/65	CHF12A	0.423	None	2105	47.6	50,000	89	66.3	◀	1.0
	CHF12B	0.423	None	2105	47.6	50,000	90	35.5	◀	1.0
	CHF12C	0.423	None	2105	47.6	53,000	89	35.5	◀	1.0
	CHF12D	0.423	None	2105	47.6	50,000	87	66.3	◀	1.0
4/ 1/65	CHF13A	0.423	None	2105	46.7	211,000	59	66.3	◀	1.0
4/ 1/65	CHF13B	0.423	None	2106	46.5	214,000	61	66.3	◀	1.0

Table 3

Film Boiling and Superheat Data - 100 KW Loop

Date	Test Section I.D. Inch	Insert	T_{sat} °F	G lb/sec-ft²	q" Btu/hr-ft²	X_{FB} %	h_{FB} Btu/hr-ft²-°F	h_{SH} Btu/hr-ft²-°F	$(\Delta T)_{SH}$ °F
2/27/65	0.423	None	2105	61.6	157,000	87			
3/27/65	0.423	None	1838	41.2	171,000	57*			
3/31/65	0.423	None	2104	47.6	94,000	96	258		
3/31/65	0.423	None	2105	47.6	49,900	96	228		
	0.423	None	2105	47.6	49,900	95 - 99			
	0.423	None	2105	47.6	52,000	98 - 96			
	0.423	None	2105	47.6	53,000	95			
4/1/65	0.423	None	2105	46.7	211,000	59*			
4/1/65	0.423	None	2106	46.5	214,000	61*			
3/31/65	0.423	None	2105	47.6	49,900			194	25

$*X_{FB}$ = X_c

X_{FB} = Quality at which stable film boiling was established

h_{FB} = Film Boiling Heat Transfer Coefficient

h_{SH} = Superheated vapor heat transfer coefficient

$(\Delta T)_{SH}$ = Degrees of superheat (°F)

NOMENCLATURE FOR TABLE 4

Symbol	Quantity	Units
$\mathcal{T}^*_{VT}$	Vapor shear stress at upper station	Dimensionless
$\mathcal{T}^*_{VB}$	Vapor shear stress at bottom station	Dimensionless
h_{VT}	Vapor phase experimental heat transfer coefficient at upper station	Btu/hr-ft^2 $^{\circ}$R
h_{VB}	Vapor phase experimental heat transfer coefficient at bottom station	Btu/hr-ft^2 $^{\circ}$R
$\overline{h}_T$	Vapor phase theoretical heat transfer coefficient for $\sigma_c = \sigma_e = 1$ (upper station)	Btu/hr-ft^2 $^{\circ}$R
σ_{TE}	Experimental condensation coefficient at upper station	Dimensionless
$\overline{h}_B$	Vapor phase theoretical heat transfer coefficient for $\sigma_c = \sigma_e = 1$ (bottom station)	Btu/hr-ft^2 $^{\circ}$R
σ_{BE}	Experimental condensation coefficient at bottom station	Dimensionless

Table 4.

Table 4. Vapor Phase Heat Transfer Coefficients – 50 KW Project*

A. Tubular Insert (Test Set No. 5)

Run No.	$\dot{\gamma}^*_{VT}$	$\dot{\gamma}^*_{VB}$	h_{VT}	h_{VB}	$\bar{h}_T$	σ_{TE}	$\bar{h}_B$	σ_{BE}
1	7.1252+1	4.1314+0	2.0318+4	2.4445+4	7.0446+4	2.8842-1	7.2420+4	3.3755-1
2	5.4938+1	3.2319+0	2.0416+4	2.7149+4	8.6295+4	2.3659-1	8.7600+4	3.0992-1
3	3.3665+1	2.0042+0	2.5323+4	2.8226+4	1.1150+5	2.2710-1	1.1205+5	2.5191-1
4	2.1124+1	1.2640+0	3.8989+4	2.6678+4	1.4832+5	2.6287-1	1.4832+5	1.7987-1
5	6.2961+1	3.7079+0	2.0480+4	2.4701+4	1.4527+5	1.4098-1	1.4710+5	1.6792-1
6	8.9404+1	5.2055+0	1.9907+4	3.3584+4	1.1423+5	1.7427-1	1.1695+5	2.8715-1
7	1.4068+2	7.9103+0	1.9465+4	2.3404+4	8.4990+4	2.2903-1	8.9900+4	2.6033-1
8	1.7046+2	9.3146+0	1.8680+4	2.3457+4	7.0800+4	2.6385-1	7.6875+4	3.0513-1
9	2.2680+2	1.1896+1	1.8780+4	2.3795+4	7.0446+4	2.6659-1	7.9335+4	2.9993-1
10	1.7126+2	9.4385+0	1.8475+4	2.5060+4	8.7600+4	2.1090-1	9.4040+4	2.6648-1
11	1.3034+2	7.4741+0	2.2685+4	2.4741+4	1.1205+5	2.0245-1	1.1641+5	2.1253-1
12	7.1363+1	4.2273+0	2.6523+4	2.5357+4	1.7776+5	1.4921-1	1.7913+5	1.4156-1
13	4.1504+1	2.4727+0	3.1596+4	2.0627+4	2.6082+5	1.2114-1	2.6170+5	7.8820-2
14	5.1184+1	3.0493+0	3.0774+4	2.3293+4	2.5907+5	1.1878-1	2.5995+5	8.9605-2
15	9.5323+1	5.6220+0	2.3254+4	2.4118+4	1.8200+5	1.2777-1	1.8425+5	1.3090-1
16	1.4334+2	8.2705+0	1.9244+4	2.2857+4	1.3666+5	1.4082-1	1.4100+5	1.6210-1
17	1.7592+2	9.9284+0	1.6556+4	2.0862+4	1.1695+5	1.4156-1	1.2305+5	1.6954-1
18	3.1121+2	1.6345+1	1.8982+4	2.3448+4	1.0415+5	1.8225-1	1.1695+5	2.0049-1
19	2.1907+2	1.2370+1	2.1334+4	2.6040+4	1.4283+5	1.4936-1	1.4954+5	1.7413-1
20	1.7339+2	1.0095+1	2.2491+4	2.8590+4	1.7296+5	1.3003-1	1.7707+5	1.6146-1
21	9.8530+1	5.8480+0	2.4872+4	2.4754+4	2.5120+5	9.9013-2	2.5295+5	9.7862-2
22	1.4463+2	8.5816+0	2.3861+4	2.2567+4	2.5645+5	9.3045-2	2.5820+5	8.7403-2
23	2.4619+2	1.4163+1	2.4903+4	2.1989+4	1.7844+5	1.3956-1	1.8425+5	1.1934-1
24	2.6046+2	1.4185+1	2.3178+4	2.5187+4	1.7022+5	1.3616-1	1.8425+5	1.3670-1
25	3.2362+2	1.7904+1	1.8716+4	2.0455+4	1.4283+5	1.3103-1	1.5198+5	1.3459-1
26	4.2129+2	2.4439+1	1.9030+4	2.1812+4	1.1150+5	1.7066-1	1.1477+5	1.9004-1
27	4.3456+2	2.3993+1	2.2025+4	2.7694+4	1.4710+5	1.4973-1	1.5728+5	1.7608-1
28	3.6049+2	2.0528+1	2.1646+4	2.9587+4	1.7707+5	1.2224-1	1.8425+5	1.6058-1
29	2.0323+2	1.1956+1	2.2912+4	2.3023+4	2.6620+5	8.6072-2	2.6980+5	8.5335-2
30	2.7589+2	1.6017+1	2.6003+4	3.0092+4	2.6350+5	6.9774-2	2.6980+5	1.1153-1
31	4.7393+2	2.5644+1	1.8023+4	3.5614+4	1.7228+5	1.0461-1	1.8725+5	1.9020-1
32	5.9595+2	3.3890+1	2.6003+4	5.2001+4	1.6817+5	1.5463-1	1.7570+5	2.9595-1
33	6.0164+2	3.6916+1	2.0772+4	3.3257+4	1.5388+5	1.3499-1	1.5076+5	2.2060-1
34	7.4718+2	1.1333+2	1.9755+4	3.5948+3	1.2194+5	1.6201-1	5.4513+4	6.5943-2
35	7.6286+2	1.1036+2	1.8196+4	3.7926+3	9.4500+4	1.9255-1	4.3988+4	8.6220-2
36	9.2937+2	2.7962+2	1.7400+4	1.1917+3	6.6906+4	2.6006-1	1.6486+4	7.2283-2
37	3.6289+2	1.8519+1	1.8061+4	1.4942+4	9.0360+4	1.9988-1	1.0366+5	1.4415-1

*Nomenclature for Table 4 given on preceding page

Table 4. Vapor Phase Heat Transfer Coefficients - 50 KW Project (Continued)

B. Helical Insert (Test Set No. 4)

Run No.	τ_{VT}^*	τ_{VB}^*	h_{VT}	h_{VB}	$\bar{h}_T$	σ_{TE}	$\bar{h}_B$	σ_{BE}
1	4.6371+1	2.8072+0	3.9153+4	1.5031+4	1.0464+5	3.7417-1	1.0366+5	1.4500-1
2	2.6963+1	1.6219+0	2.8877+4	1.2811+4	1.4161+5	2.0392-1	1.4100+5	9.0855-2
3	1.4483+2	8.8129+0	1.0818+5	1.6769+4	8.9900+4	1.2033+0	8.8520+4	1.8944-1
4	9.1672+1	5.5414+0	3.8207+4	2.2287+4	1.2527+5	3.0500-1	1.2416+5	1.7950-1
5	5.4022+1	3.2479+0	2.4980+4	2.3201+4	1.7296+5	1.4442-1	1.7228+5	1.3467-1
6	2.4144+1	1.4505+0	2.8548+4	1.8887+4	2.5645+5	1.1132-1	2.5557+5	7.3900-2
7	5.5621+1	3.3426+0	3.0249+4	2.0498+4	2.4945+5	1.2126-1	2.4857+5	8.2463-2
8	1.1716+2	7.0469+0	3.6672+4	2.2187+4	1.6340+5	2.2443-1	1.6272+5	1.3635-1
9	2.0038+2	1.2320+1	6.2533+4	2.1587+4	1.1641+5	5.3718-1	1.1368+5	1.8988-1
10	3.3459+2	2.4797+1	1.6203+5	2.4912+4	6.7968+4	2.3839+0	5.6820+4	4.3844-1
11	2.2221+2	1.4213+1	1.3012+5	2.2537+4	8.4990+4	1.5310+0	8.0205+4	2.8100-1
12	1.4494+2	8.8542+0	6.2098+4	2.5725+4	1.1423+5	5.4362-1	1.1205+5	2.2959-1
13	1.9226+2	1.1895+1	6.9080+4	2.4735+4	1.1805+5	5.8515-1	1.1477+5	2.1551-1
14	2.3216+2	1.5158+1	5.4198+4	2.6228+4	1.1314+5	4.7903-1	1.0464+5	2.5065-1
15	2.1629+2	1.4140+1	3.8593+4	3.0462+4	1.4466+5	2.6678-1	1.3418+5	2.2702-1
16	1.7590+2	1.0996+1	3.4686+4	3.1711+5	1.7091+5	2.0295-1	1.6476+5	1.9247-1
17	8.3589+1	5.0468+0	3.6478+4	3.5571+4	2.6350+5	1.3844-1	2.6170+5	1.3592-1
18	1.4370+2	8.7540+0	3.1911+4	3.5043+4	2.6170+5	1.2194-1	2.5820+5	1.3572-1
19	2.6196+2	1.7371+1	3.2685+4	2.9706+4	1.7091+5	1.9124-1	1.5660+5	1.8969-1
20	3.4740+2	2.5329+1	3.4935+4	2.5131+4	1.3604+5	2.5680-1	1.1477+5	2.1896-1
21	5.0251+2	6.0197+1	2.7452+4	2.4918+4	1.0170+5	2.6993-1	5.5831+4	4.4630-1
22	4.9724+2	5.0461+1	2.7032+4	4.2861+4	1.3480+5	2.0053-1	8.4990+4	5.0431-1
23	3.5891+2	2.6135+1	3.2375+4	6.4982+4	1.6885+5	1.9173-1	1.4344+5	4.5303-1
24	2.3266+2	1.4898+1	3.1505+4	1.8261+5	2.5470+5	1.2369-1	2.4080+5	7.5834-1
25	2.9009+2	1.9097+1	2.6758+4	1.5491+5	2.5032+5	1.0689-1	2.3145+5	6.6930-1
26	4.7873+2	4.0047+1	3.1494+4	6.1126+4	1.6544+5	1.9037-1	1.2471+5	4.9013-1
27	6.2971+2	6.9797+1	3.0836+4	3.6445+4	1.6612+5	1.8562-1	9.7780+4	3.7273-1
28	3.3729+2	2.2778+1	3.0304+4	2.0633+6	2.5207+5	1.2022-1	2.2805+5	9.0477+0
29	4.3028+2	3.2476+1	2.6935+4	8.3685+4	2.3655+5	1.1387-1	1.9550+5	4.2806-1
30	1.1364+2	7.5011+0	7.6701+4	6.7226+4	8.8520+4	8.6648-1	8.1075+4	8.2918-1
31	1.7027+2	1.1069+1	2.4208+4	9.7863+4	6.9738+4	3.4713+0	6.5136+4	1.5024+0
32	6.8991+2	4.3299+1	1.0756+5	7.3786+4	6.4782+4	1.6603+0	6.2340+4	1.1836+0
33	3.7086+2	2.2703+1	3.3434+4	4.8069+4	9.0360+4	3.7001-1	8.8520+4	5.4303-1

Table 5. Comparison of Experimental Data and Correlation
          - 50 KW Project

A. Tubular Insert (Test Set No. 5) $\sigma_e = \sigma_c = 0.19$

Run No.	% Error at Top Position	% Error at Bottom Position
1	-48	-48
2	-22	-36
3	-17	-18
4	-31	- 3
5	23	6
6	8	-24
7	-19	-21
8	-36	-36
9	-38	-33
10	-10	-22
11	- 6	- 6
12	18	13
13	29	32
14	30	26
15	29	15
16	24	8
17	24	6
18	4	- 3
19	19	4
20	28	6
21	41	22
22	44	24
23	24	18
24	25	12
25	29	15
26	9	0
27	19	3
28	32	6
29	48	23
30	56	14
31	42	0
32	17	-14
33	27	- 6
34	14	59
35	- 1	50
36	-35	61
37	- 5	15

Table 5. Comparison of Experimental Data and Correlation
- 50 KW Project (Continued)

B. Helical Insert (Test Set No. 4) $\sigma_e = \sigma_c = 0.19$

Run No.	% Error at Top Position	% Error at Bottom Position
1	84	70
2	85	73
3	69	66
4	84	57
5	86	54
6	81	59
7	81	53
8	83	52
9	79	55
10	65	59
11	67	58
12	78	53
13	77	52
14	81	51
15	85	44
16	84	41
17	78	36
18	82	34
19	86	42
20	87	49
21	92	58
22	91	40
23	86	24
24	83	8
25	85	10
26	88	27
27	88	40
28	84	1
29	86	17
30	76	33
31	52	27
32	88	53
33	94	59

Friction Factor,

$$f_i = \frac{\Delta P}{\left(\frac{L}{D_i}\right)\left(\frac{\rho V_a^2}{2g_c}\right)}$$

1-inch Tube, P/D = 2 Insert

3/4-inch Tube, P/D = 6 Insert

1-inch Tube, P/D = 6 Insert

$$f = \frac{0.316}{(N_{Re})^{\frac{1}{4}}}$$

Smooth Tube (Reference 4)

Reynolds Number, $(N_{Re})_i = \frac{D_i V_a \rho}{\mu}$
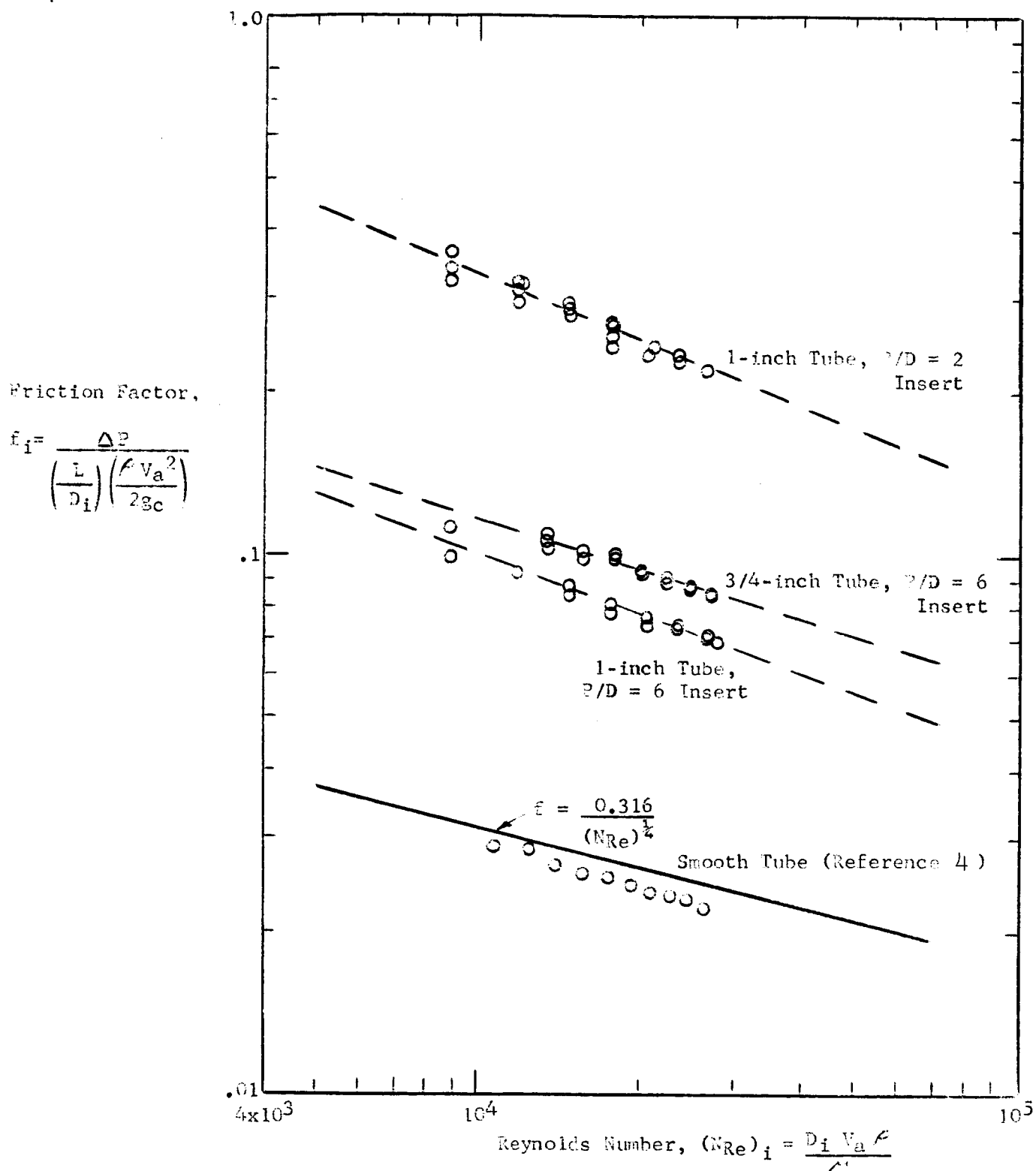
Figure 1   Experimental Single Phase Friction Factors for Water Flowing in Straight Tubes Containing Helical Inserts (300 KW Project)

-105-

The figure shows a log-log plot with Friction Factor, $f_i = \dfrac{\Delta P}{\left(\dfrac{L}{D_i}\right)\left(\dfrac{\rho V_a^2}{2g_c}\right)}$ on the vertical axis (ranging from .01 to 10.0) and Reynolds Number, $(N_{Re})_i = \dfrac{D_i V_a \rho}{\mu}$ on the horizontal axis (ranging from 3×10^3 to 10^6).

Curves labeled A through G are shown. Curve A includes the annotation:

$$f = \frac{0.316}{(N_{Re})^{\frac{1}{4}}}$$

Author		P/D_i	D_i
A-A	Ref. 4	No Insert	
B-B	SPPS	2.17	.93
C-C	SPPS	6	.93
D-D	SPPS	6	.68
E-E	Greene*	0.56	.89
F-F	Greene*	1.12	.89
G-G	Greene*	2.24	.89

*Reference 3

Figure 2   Summary of Single Phase Friction Factor Measurements from the Literature for Water Flowing in Straight Tubes Containing Helical Inserts

1.0

Author	A-A Ref.4	B-B SPPS	C-C SPPS	D-D SPPS	E-E Greene*	F-F Greene*	G-G Greene*
P/D_i	Smooth Tubes	2.17	6	6	0.56	1.12	2.24
D_i		.93	.93	.68	.89	.89	.89

*Reference 3

0.1

$$f_e = \frac{\Delta P}{\left(\frac{L_{HM}}{D_e}\right)\left(\frac{\rho_f\, V_{HM}^2}{2g_c}\right)}$$

Friction Factor, f_e

A C D B F C D B F G E A E

$$f = \frac{0.316}{(N_{Re})^{\frac{1}{4}}}$$

.01

.001

3x10³   10⁴   10⁵   10⁶

Reynolds Number, $(N_{Re})_e = \dfrac{D_e\, V_{HM}\, \rho_f}{\mu_f}$
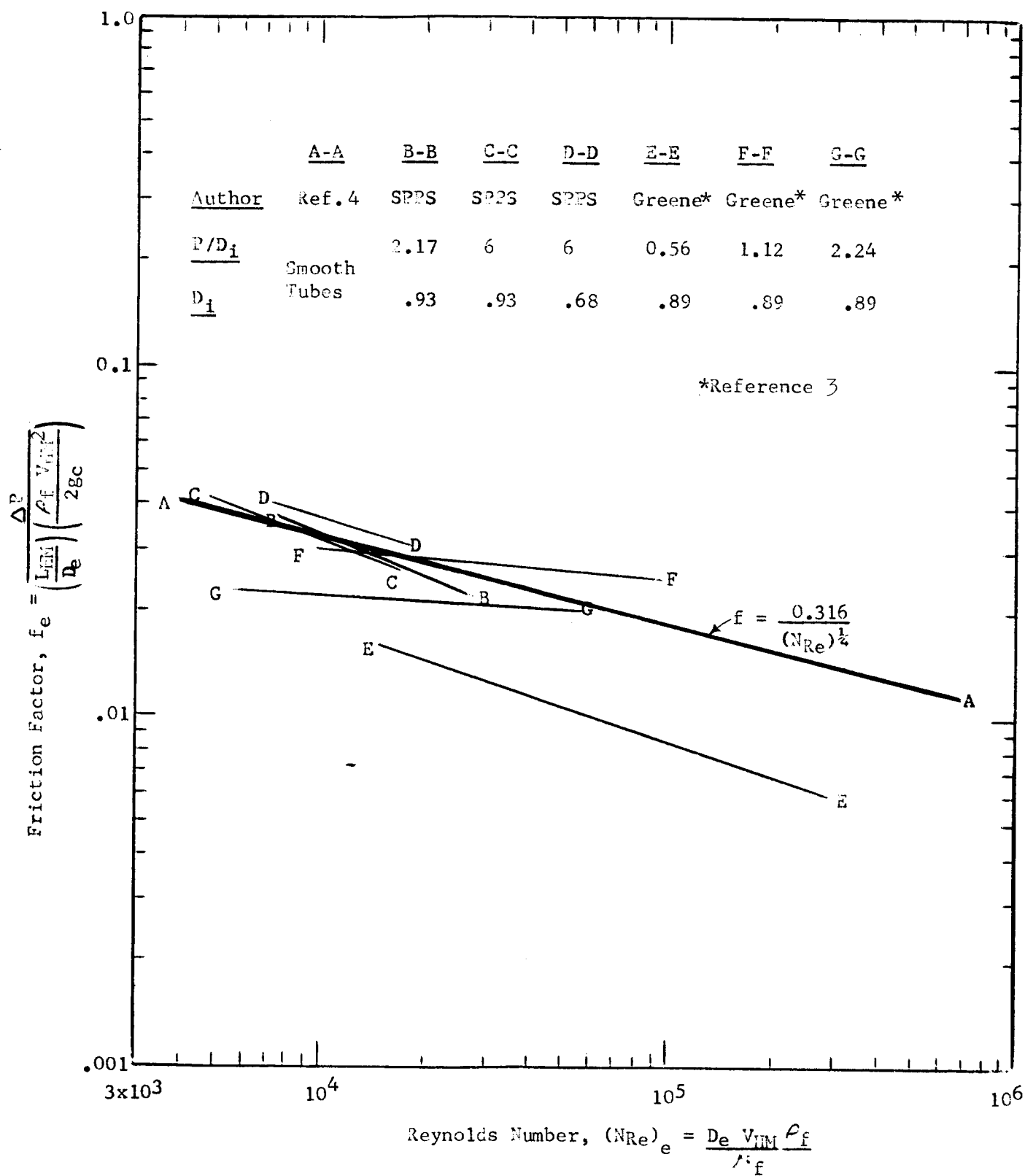
Figure 3   Relation of Helical Flow Friction Factors to the Helical Flow Reynolds Number
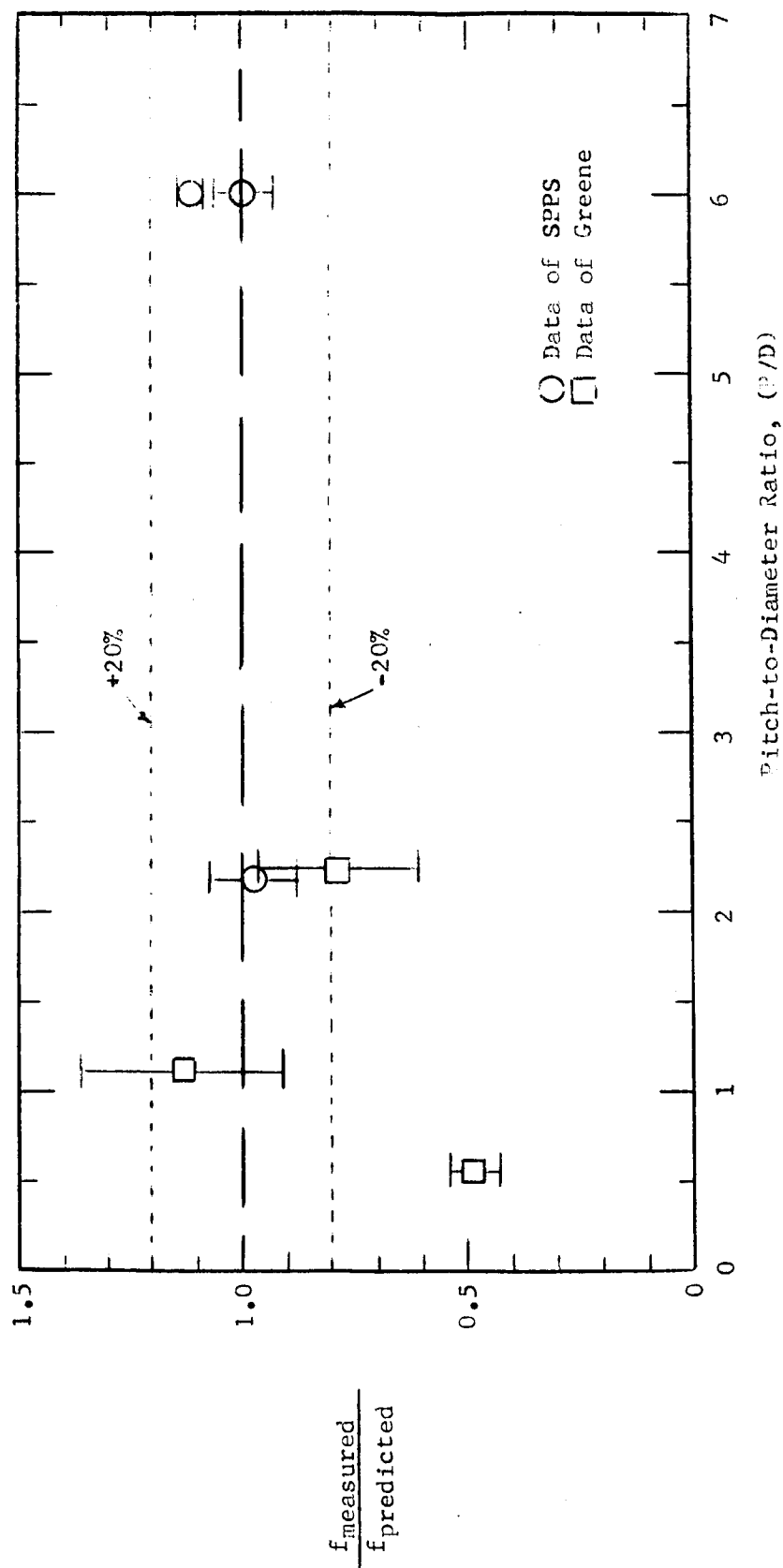
Figure 4 Comparison of Predicted and Measured Helical Single Phase Helical
Flow Friction Factors
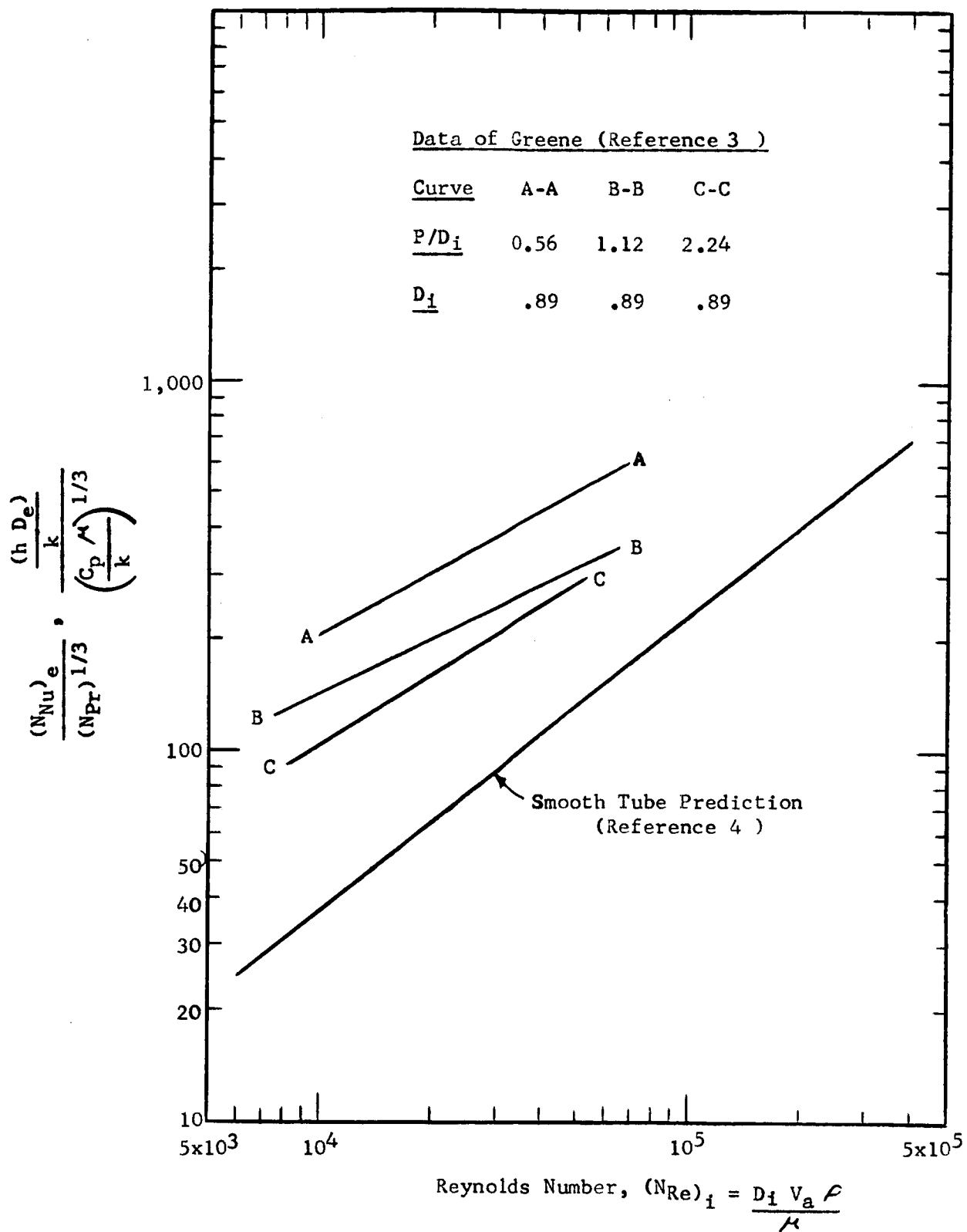
Figure 5   Summary of Heat Transfer Measurements for Water Flowing
in Straight Tubes Containing Helical Inserts

-109-
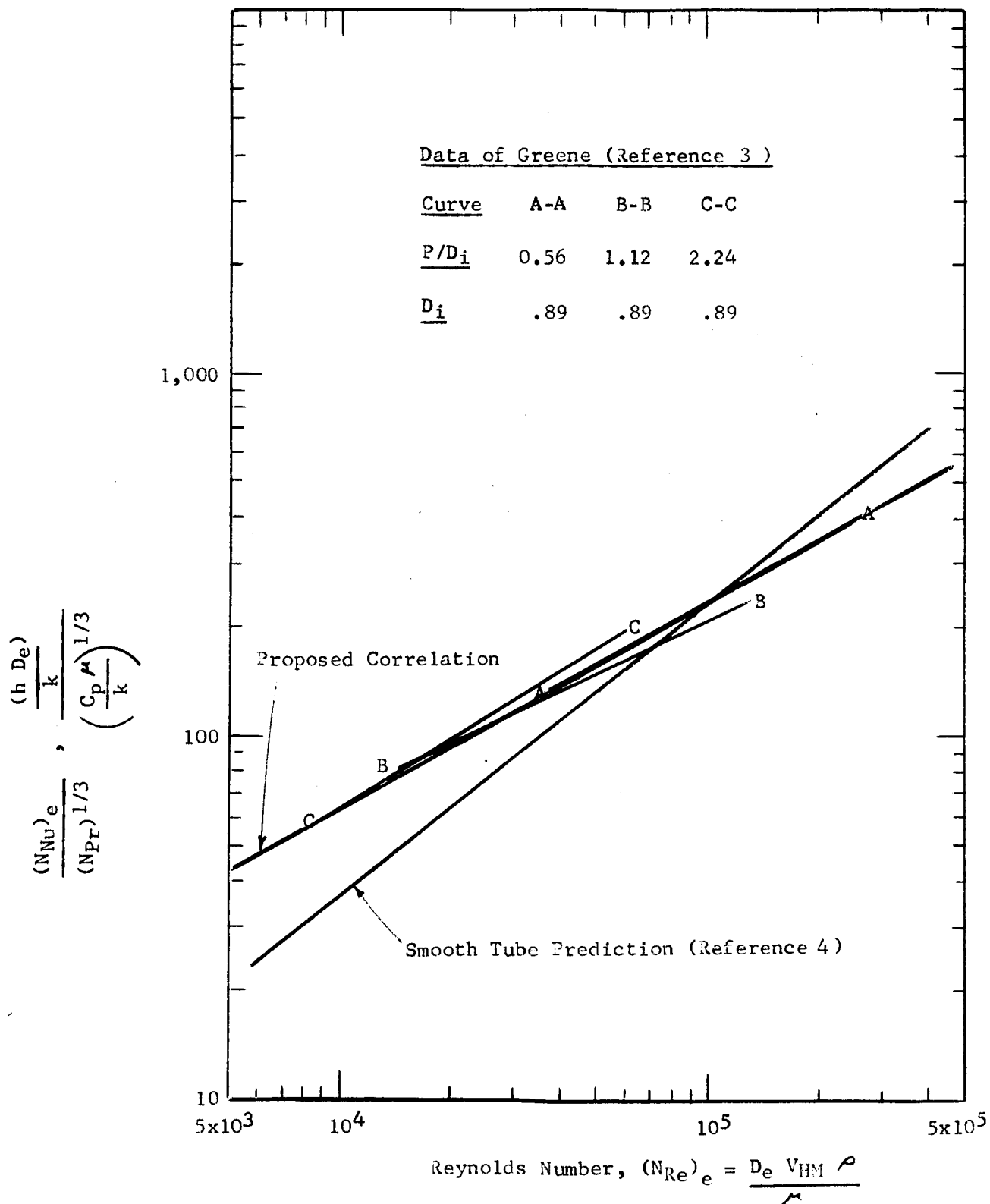
Figure 6   Correlation of Helical Flow Single Phase Heat Transfer Data
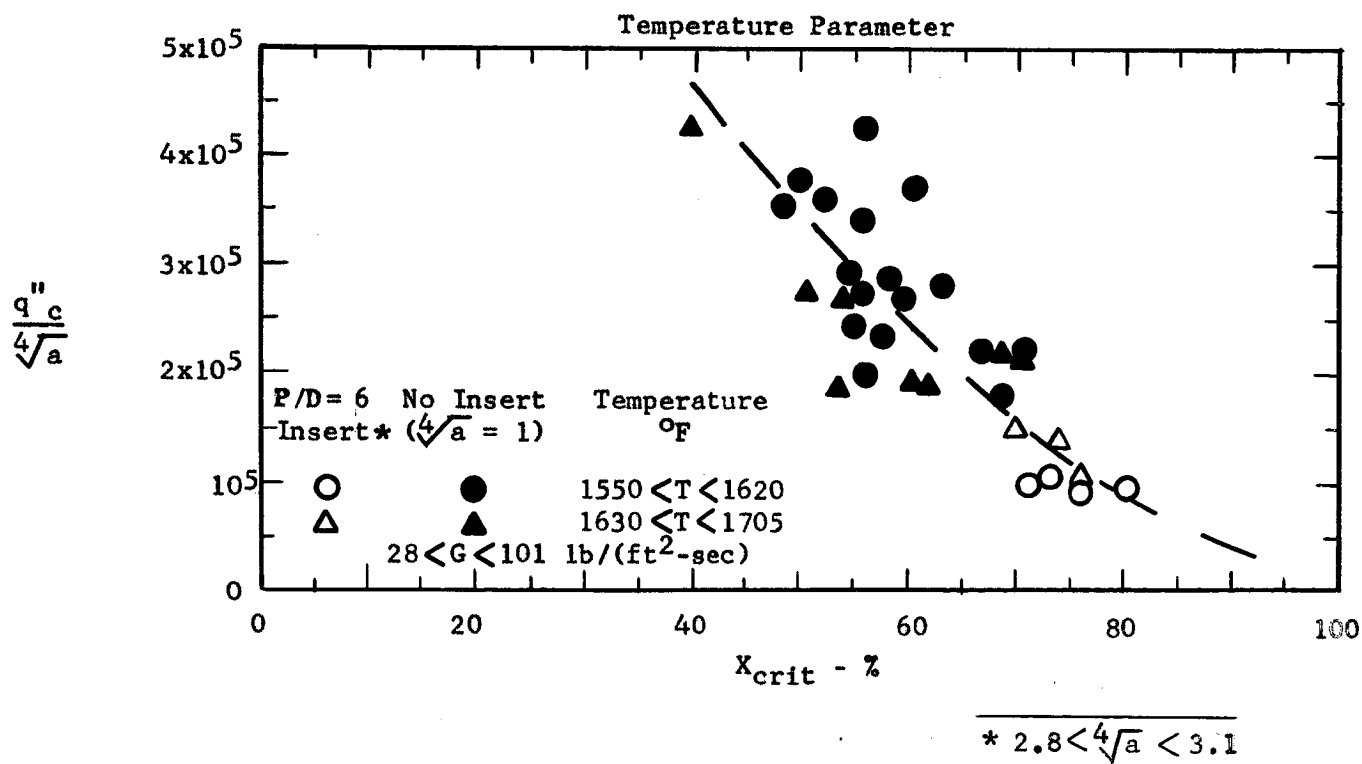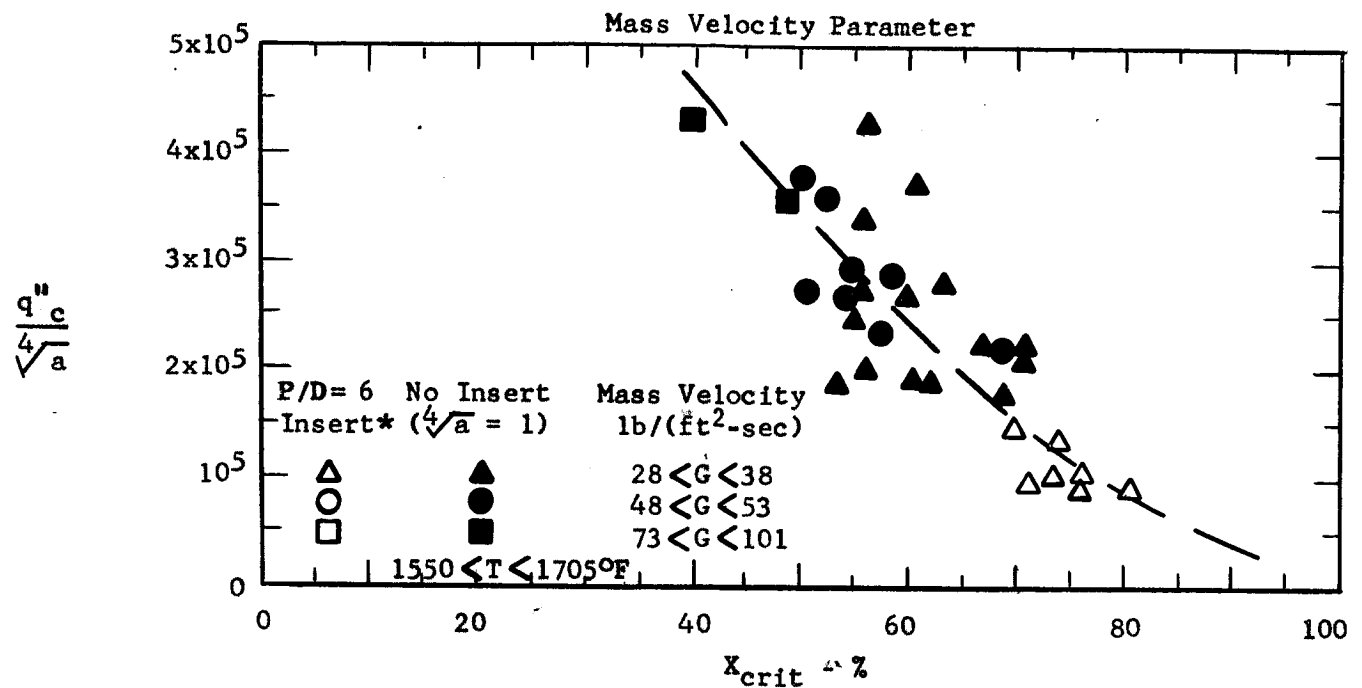
Figure 7 Critical Heat Flux Data Obtained in a 0.67-inch I.D. Tube
(300 KW Facility)
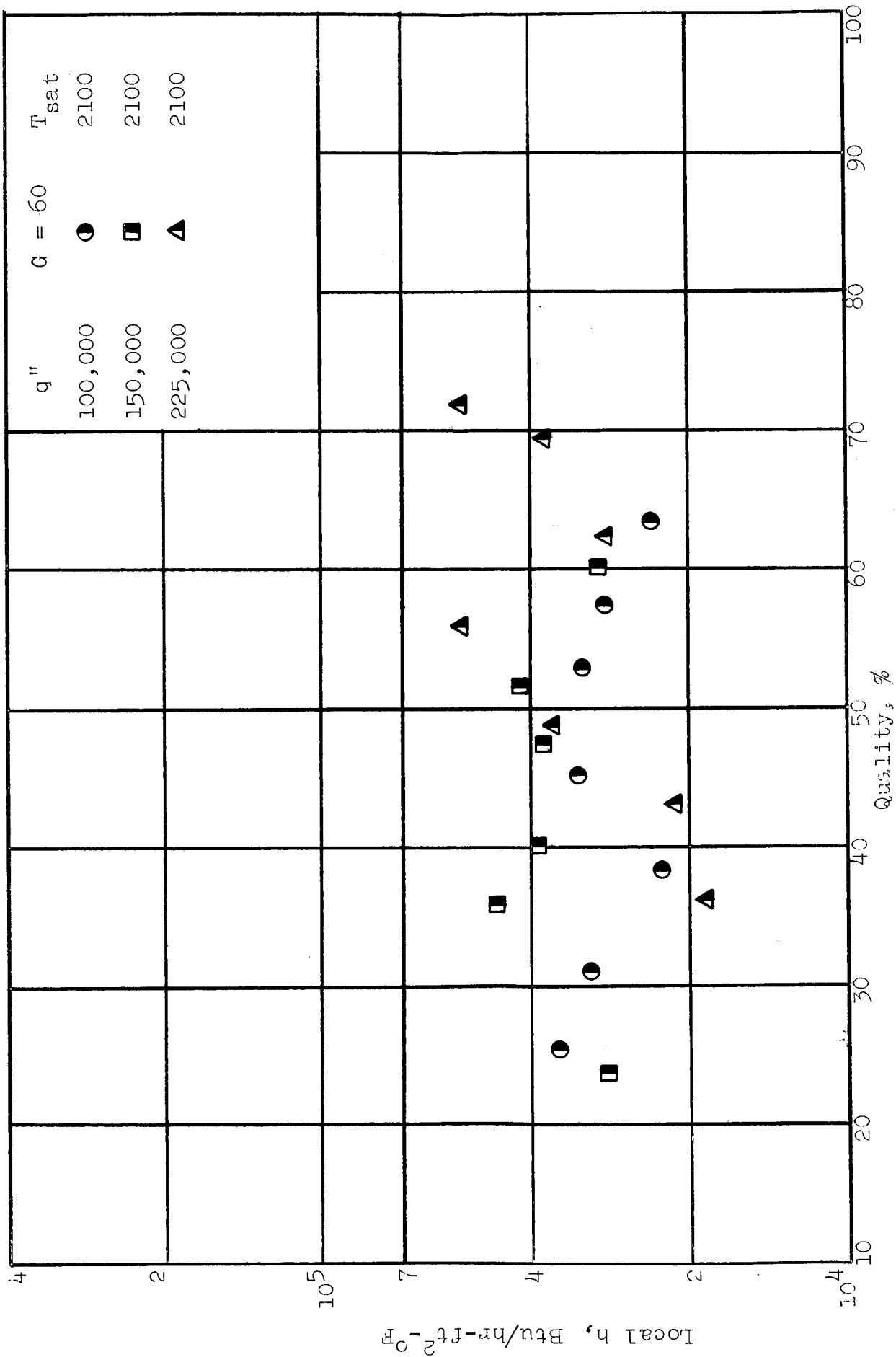
Figure 84. Nucleate Boiling Results, 100 KW Loop
(Test Section I.D. = 0.423 in., No Insert)
$T_{sat} = 2100°F$, $G = 60$ lbs/sec-ft²
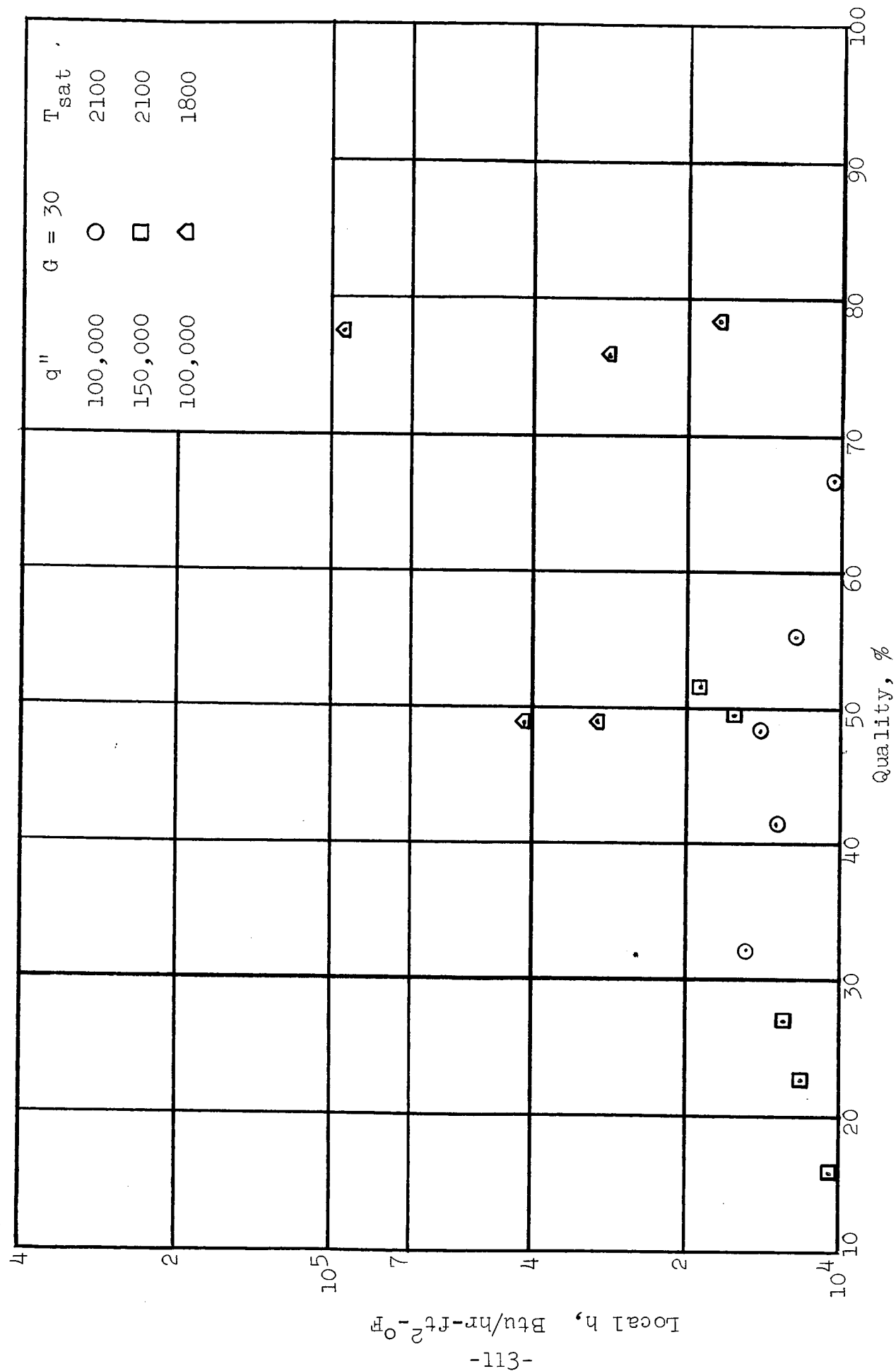
Figure 8b. Nucleate Boiling Results, 100 KW Loop
(Test Section I.D. = 0.423 in., No Insert)
T_{sat} = 1800°F and 2100°F, G = 30 lbs/sec-ft²

Quality, %

Local h, Btu/hr-ft²-°F

q"	G = 30	T_{sat}
100,000	○	2100
150,000	□	2100
100,000	◁	1800
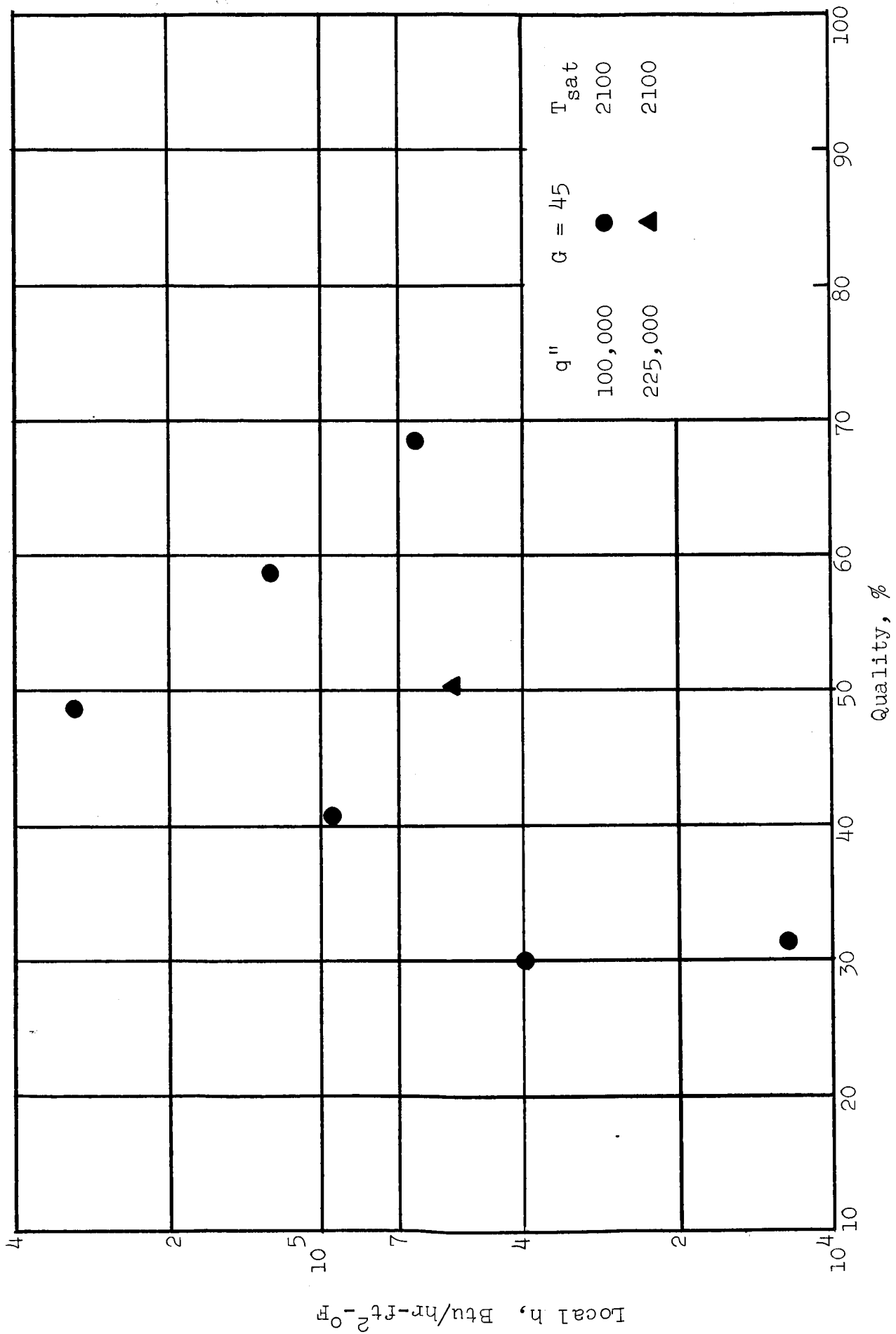
Figure 8c. Nucleate Boiling Results, 100 KW Loop
(Test Section I.D. = 0.423 in., No Insert)
T_{sat} = 2100°F, G = 45 lbs/sec-ft^2

PRESSURE
DOWNSTREAM
OF ORFICE

$\triangle P=7.4$ psi

$\triangle L=0.28$ in.

DUMP TANK
LEVEL

$G=61.6$ lb/sec ft^2
FLOW RATE

0

$\triangle T=50\,°F$

TEST SECTION
WALL TEMP.
MIDPOINT

$\triangle T=50\,°F$

TEST SECTION
WALL TEMP.
2" FROM
OUTLET

X = 65%

$\triangle T=50\,°F$

FLUID TEMP.
AT TEST
SECTION
OUTLET

Time, 1 mark/sec.
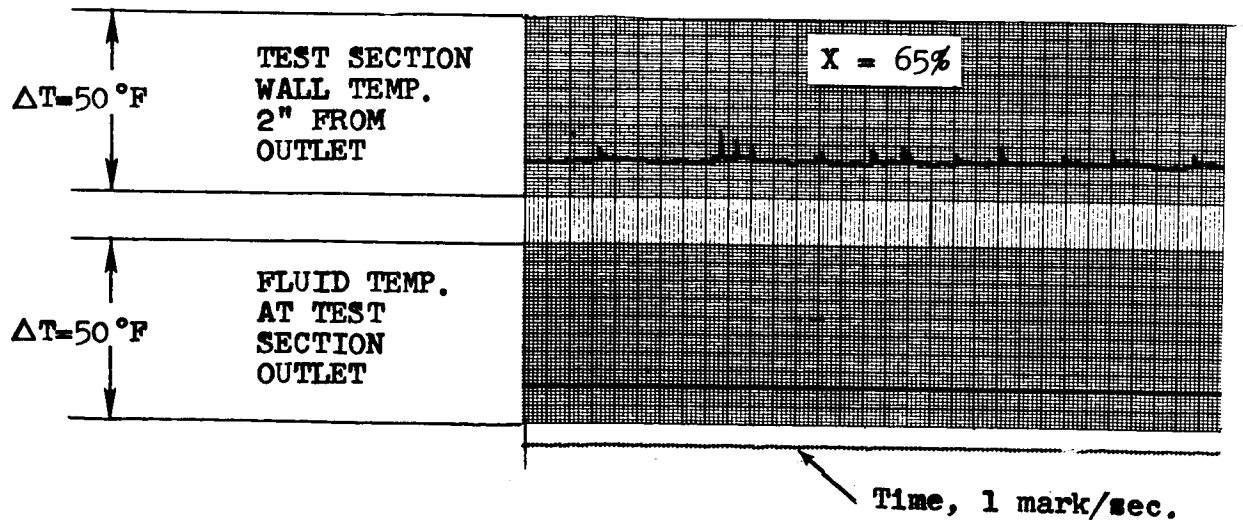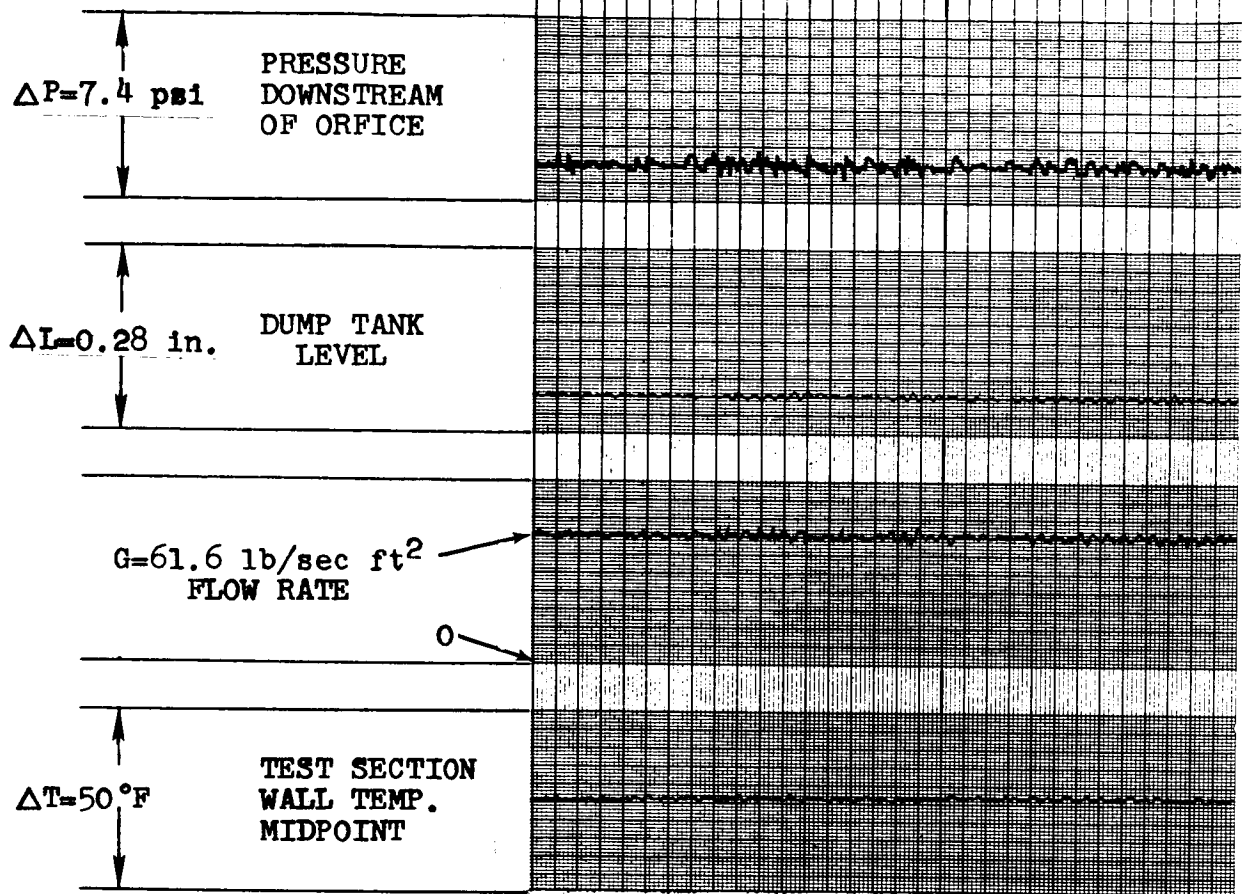
Figure 9.   Recorder Chart Showing the
Flux and Film Boiling Cond

AMPL. DIV. = .031

AMPL. DIV. = .031

PREBOILER POWER
INCREASE

ΔT=100 °F

ΔT=100 °F

X = 74%

X=77%

Onset of the Critical Heat
itions — 100KW Loop (2/27/65).

$\Delta T=250\,°F$

$\bar{X}=81\%$

$\Delta T=250\,°F$

$\bar{X}=85\%$
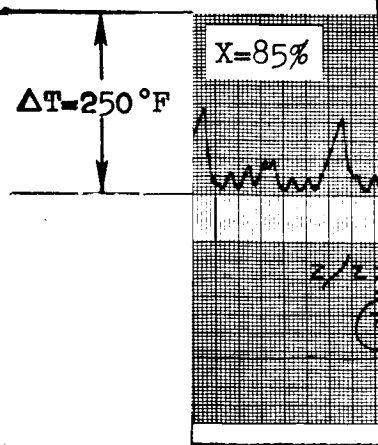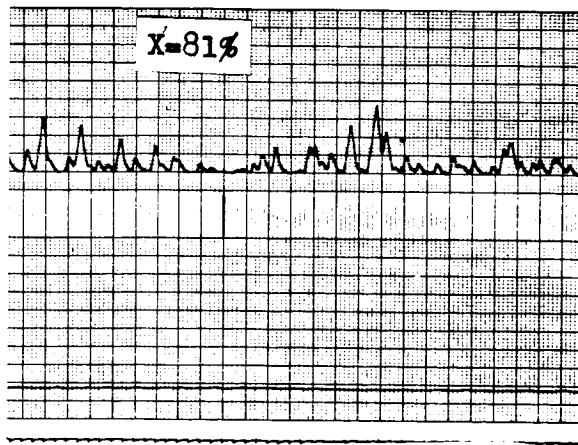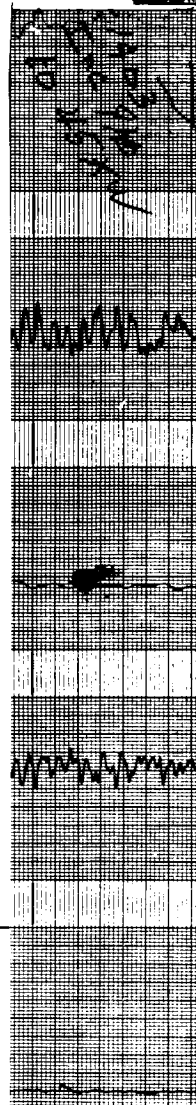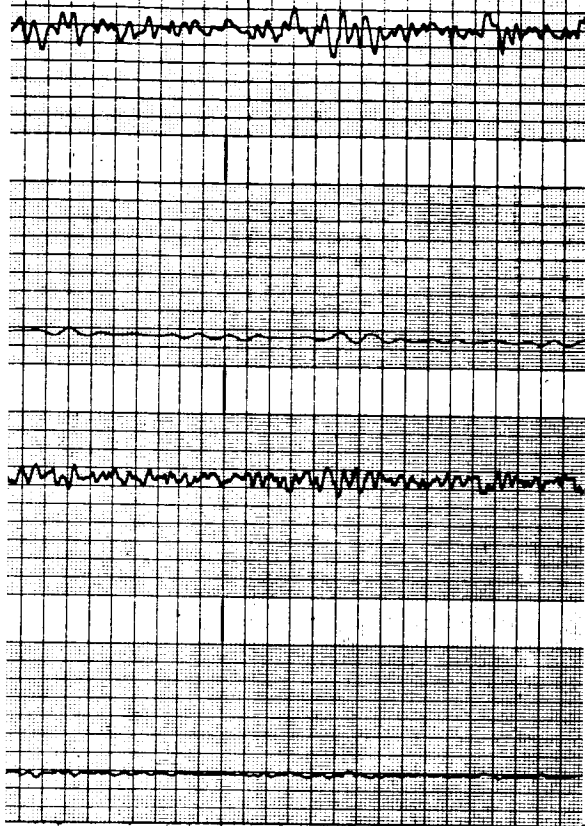
PREBOILER POWER
INCREASE
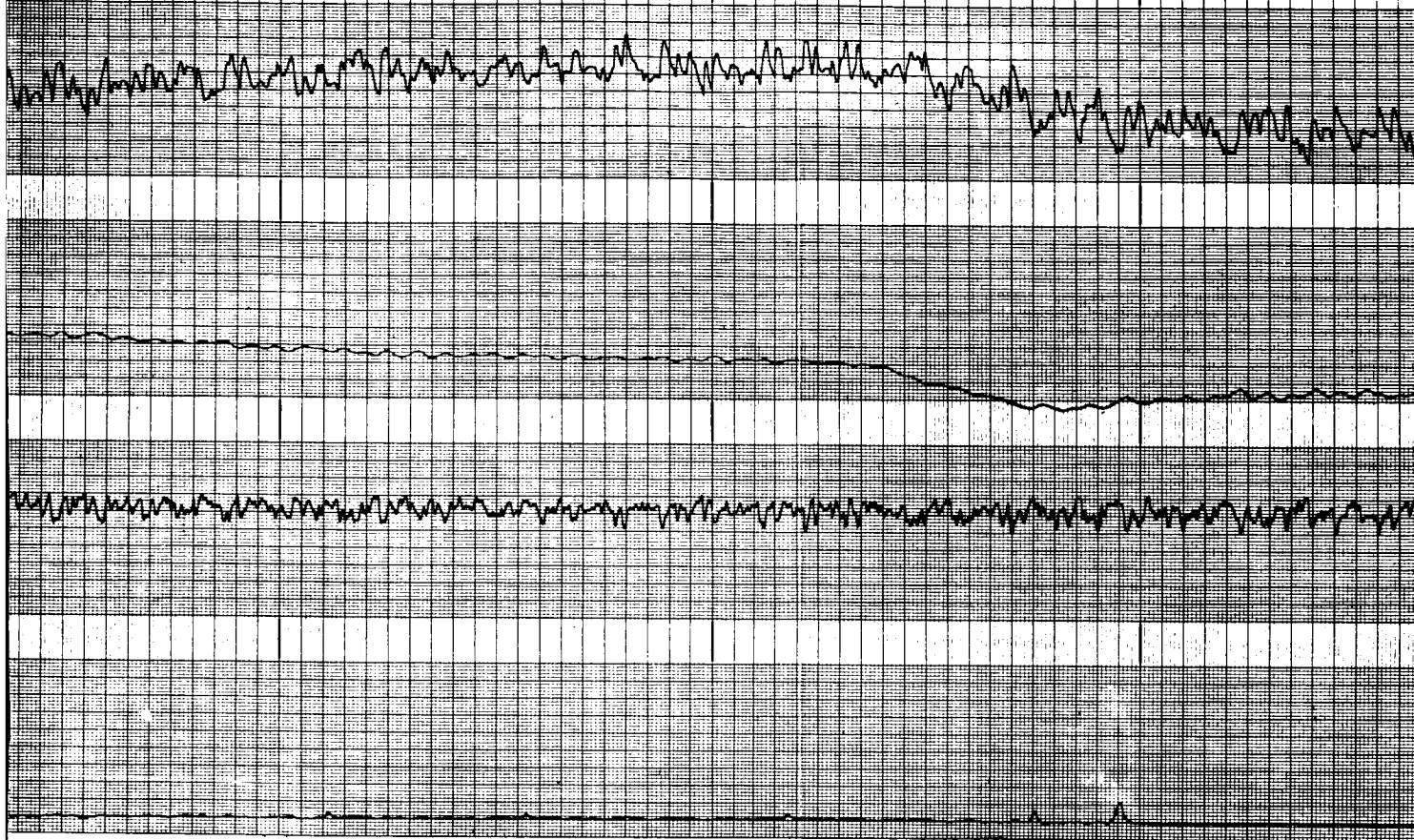
AMPL. DIV. = .031

X=87%
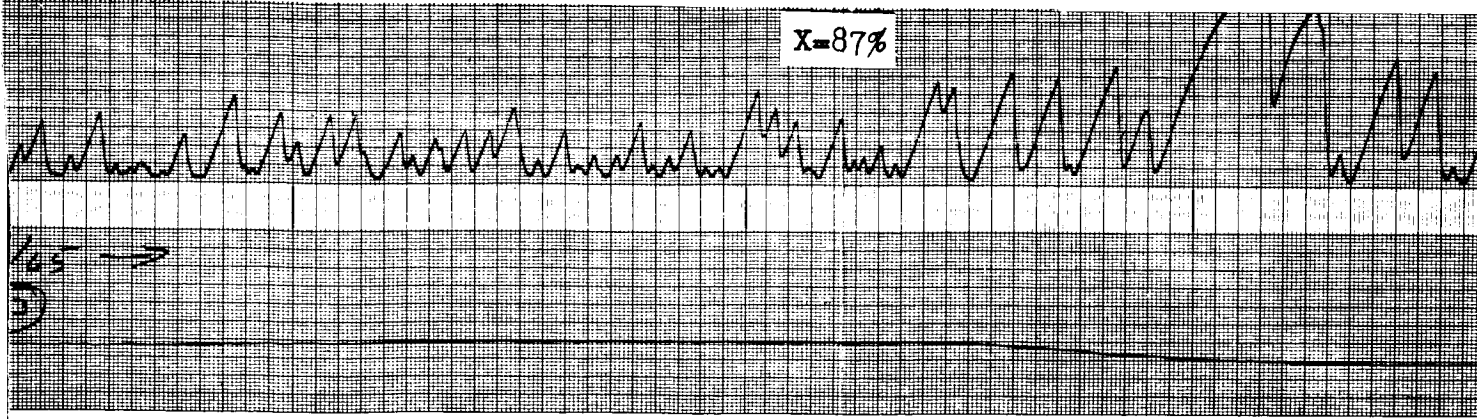
Test Section I.D. = 0.423 inch
T_{sat} = 2105°F
G = 61.6 lb/sec ft^2
q" = 157,000 Btu/hr ft^2

CORDING CHARTS   GRAPHIC CONTROLS CORPORATION   BUFFALO NEW YORK   BUFFALO NEW YORK   PRINTED IN U.S.A.

$\Delta P=3.7$ psi   PRESSURE DOWNSTREAM OF ORIFICE

$\Delta L=0.28$ in.   DUMP TANK LEVEL

$G = 61.7$ lb./sec ft^2 FLOT RATE

O

$\Delta T=50\,°F$ TEST SECTION WALL TEMP. MIDPOINT

$\Delta T=50\,°F$ TEST SECTION WALL TEMP. 2" FROM OUTLET

$\Delta T=50\,°F$ TEST SECTION WALL TEMP. 2" FROM OUTLET

X=69%   X=72%

$\Delta T=50\,°F$ FLUID TEMP. AT TEST SECTION OUTLET

Time, 1 mark/sec.
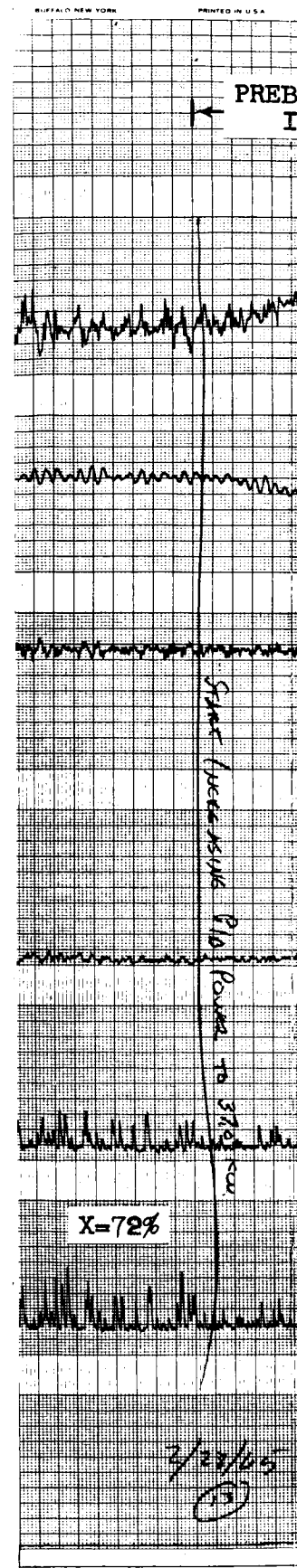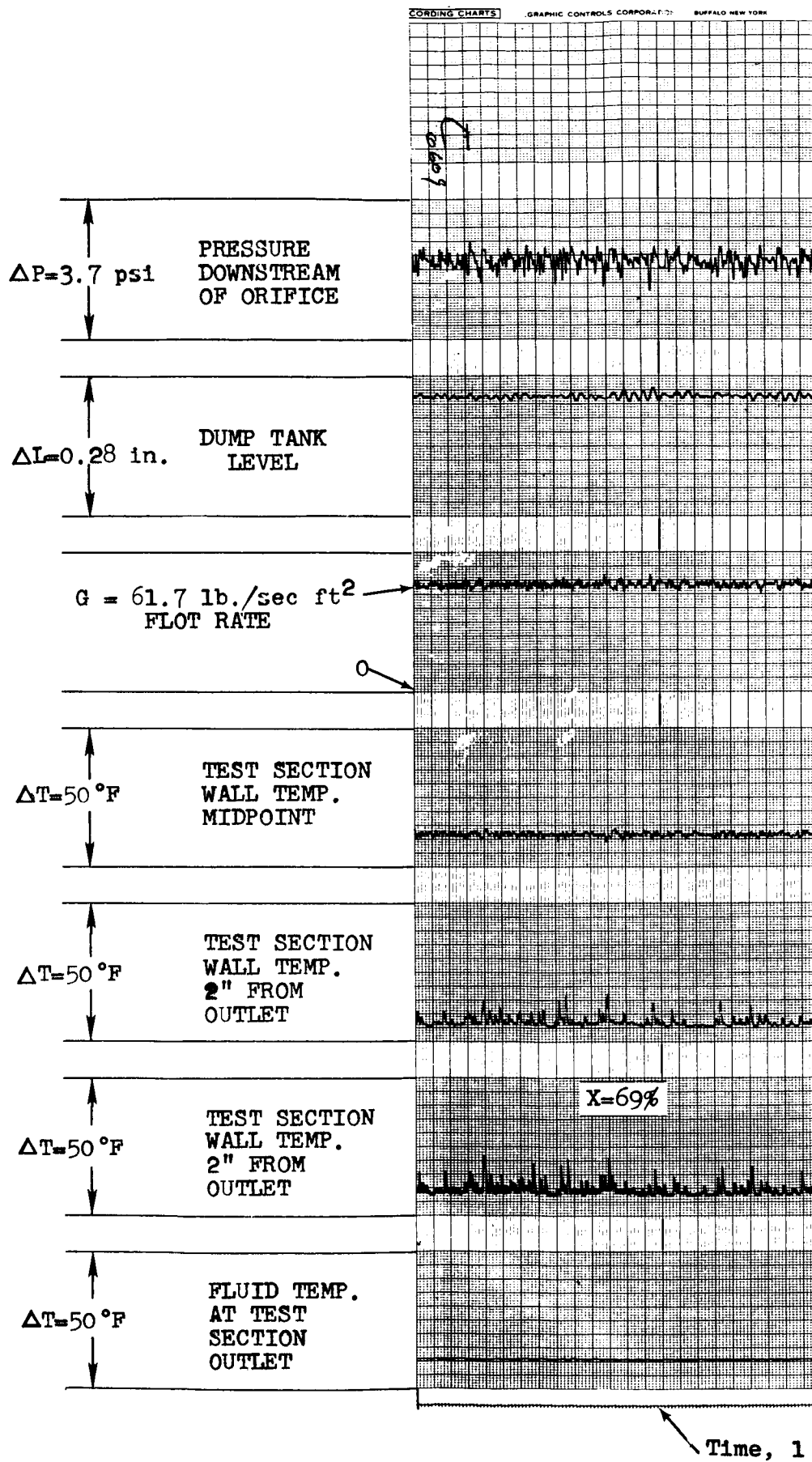
Figure 10.   Recorder Chart Showing the C
Flux Condition - 100KW Loop

AMPL. DIV. .031 **RECORDING CHARTS** GRAPHIC CONTROLS CORPORATION   BUFFALO NEW YORK   PRINTED IN U.S.A

OILER POWER
NCREASE

← PREBOILER POWER
DECREASE
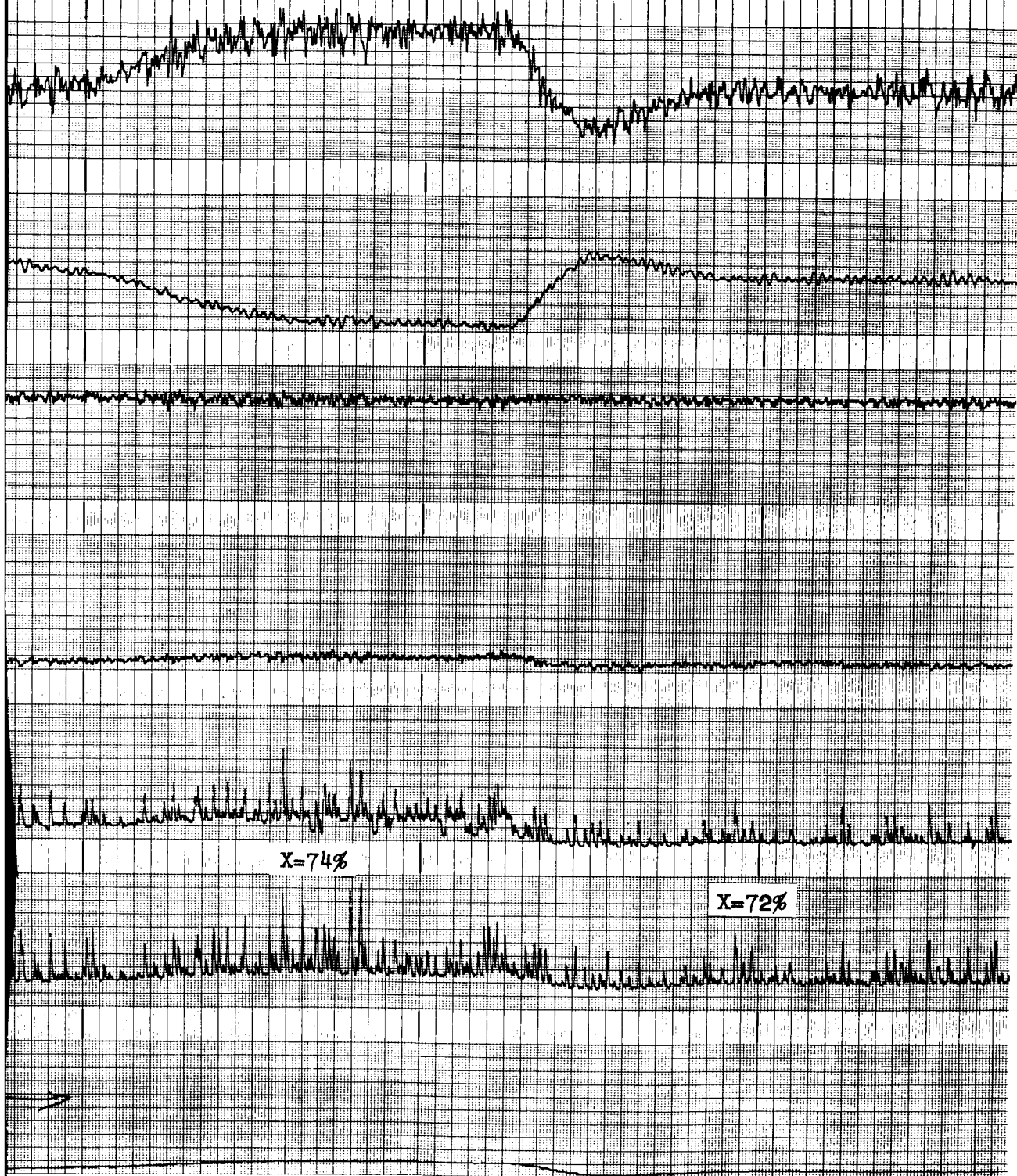
X=74%

X=72%

Test Section I.D. = 0.423 inch

T_{sat} = 2102°F

G = 61.7 lb./sec ft^2

q" = 224.000 Btu/hr ft^2

nset of the Critical Heat
(2/28/65).

Figure 11.   Recorder Chart Showing the Onset of the Critical Heat
Flux Condition - 100KW Loop (3/17/65).

3

Segment 4

Segment 5

ft²

q"=100,000 Btu/Hr. ft²

q"=104,000 Btu/Hr. ft²

ΔP=18.6 psi

ΔT=100 °F

ΔT=100 °F

X=89%

ΔT=100 °F

X=91%
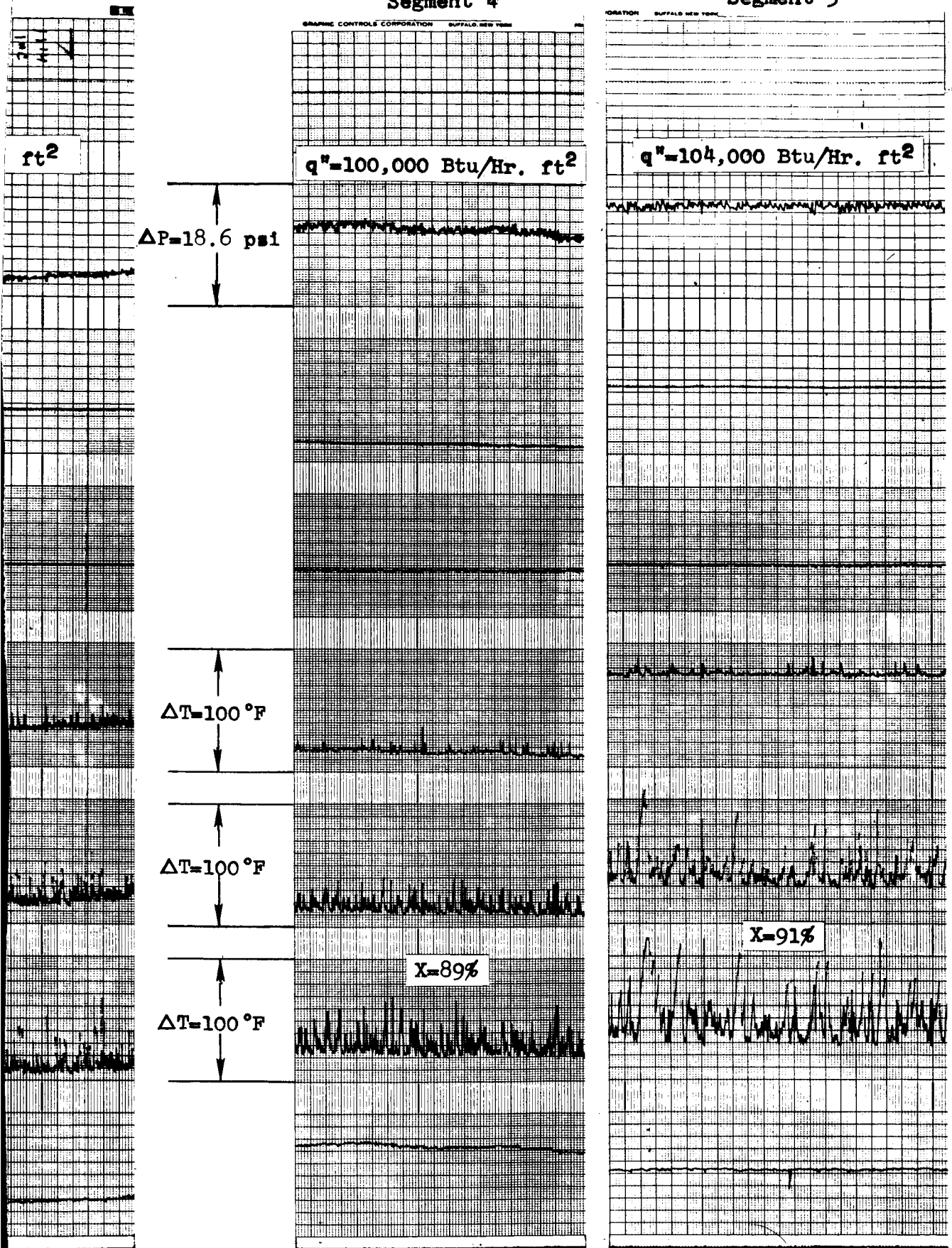
Test Section I.D. = 0.423 inch
T_{sat} = 2100 °F
G = 31 lb./sec ft²

-119-

$\Delta P = 36.9$ psi — PRESSURE UPSTREAM OF ORIFICE

$\Delta P = 37.2$ psi — PRESSURE DOWNSTREAM OF ORIFICE

$\Delta L = 1.4$ in. — DUMP TANK LEVEL

FLOW RATE $G = 41.2$ lb/sec ft^2

$\Delta T = 250°F$ — TEST SECTION WALL TEMP. MIDPOINT

$\Delta T = 250°F$ — FLUID TEMP. AT TEST SECTION OUTLET

$\Delta T = 250°F$ — TEST SECTION WALL TEMP. 2" FROM OUTLET

TEST SECTION POWER INCREASE

$q'' = 157,000$ Btu/Hr. ft^2

$q'' = 164,000$ Btu/Hr. ft^2

X = 53%

X = 55%
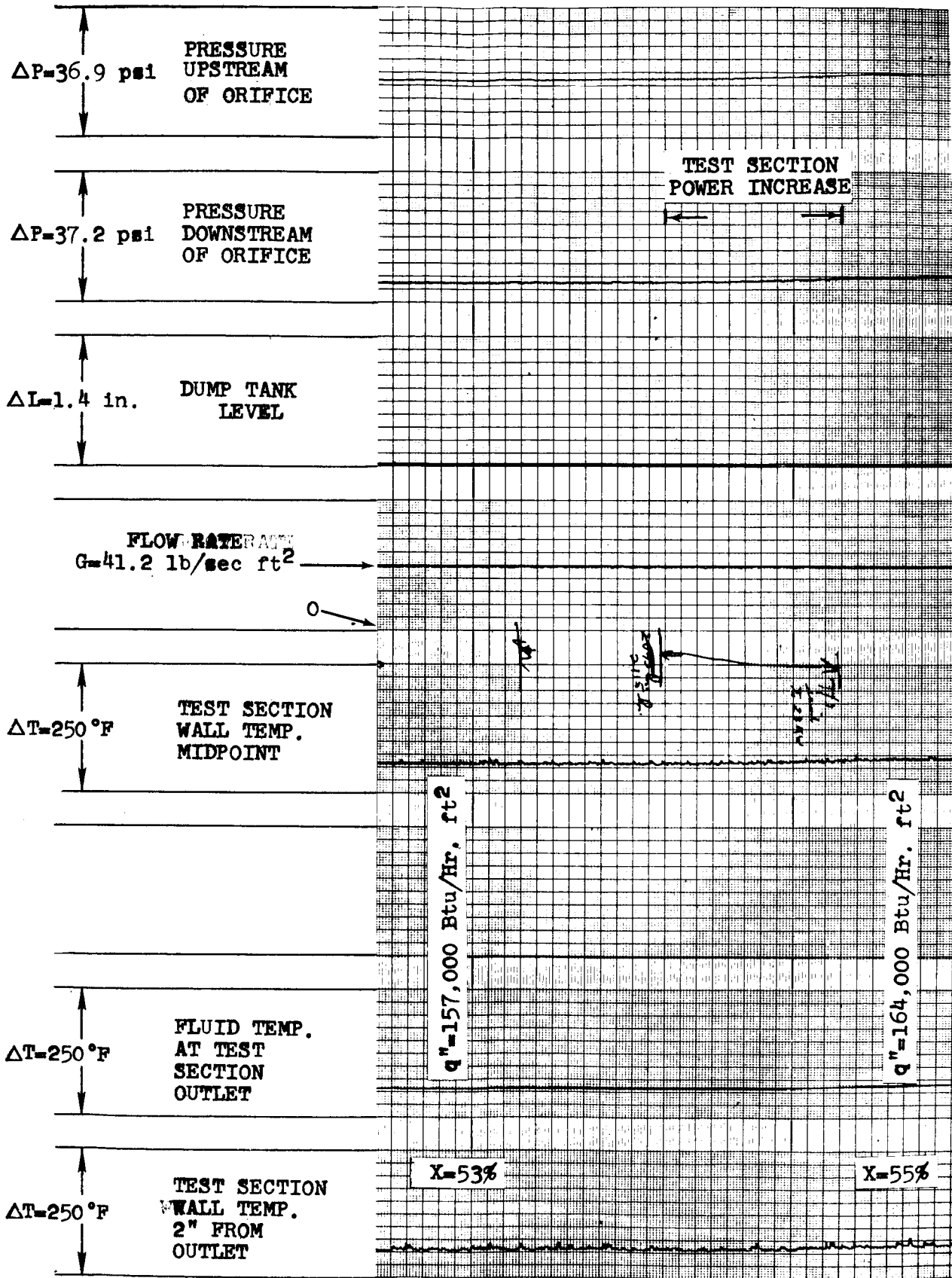
Figure 12. Recorder Chart Showin Flux Condition - 100K

TEST SECTION
POWER INCREASE

TEST SECTION
POWER TRIP

1 Minute

$q'' = 171,000$ Btu/Hr. ft^2

3/27/65

X=55%

X=57%

g the Onset of the Critical Heat
W Loop (3/27/65).
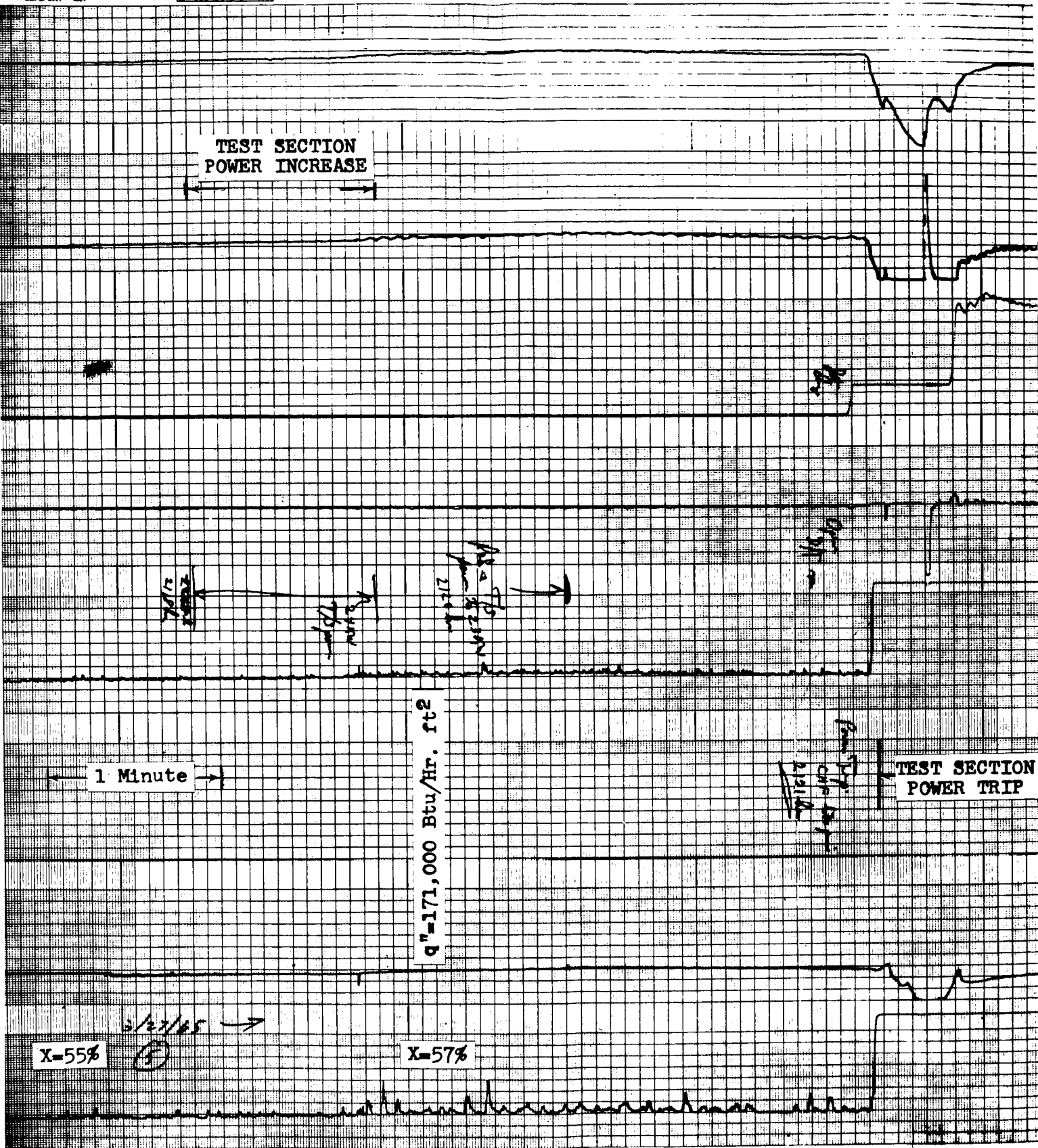
Test Section I.D. = 0.423 Inch
T_{sat} = 1838 °F
G = 41.2 lb/sec ft^2
q_c'' = 171,000 Btu/hr. ft^2
X_c = 57%

PREBOILER POWER
INCREASE

$\Delta P = 36.9$ psi
PRESSURE
UPSTREAM
AT ORIFICE

$\Delta P = 37.2$ psi
PRESSURE
DOWNSTREAM
AT ORIFICE

$\Delta L = 1.41$ in.
DUMP TANK
LEVEL

FLOW RATE
$G = 47.6$ lb/sec ft^2

$\Delta T = 250\,^\circ F$
TEST SECTION
WALL TEMP.
MIDPOINT

$q'' = 97,000$ Btu/hr. ft^2
1143 Hrs. (3/31/65)

$\Delta T = 250\,^\circ F$
FLUID TEMP.
AT TEST
SECTION
OUTLET

$\Delta T = 250\,^\circ F$
TEST SECTION
WALL TEMP.
2" FROM
OUTLET

Time

ent 1

AMPL. DIV. — .031

AMPL. DIV. — .031 |8 RECORDING CHARTS| GRAPHIC CO

PREBOILER POWER INCREASE

q''=95,000 Btu/hr. ft^2
1155 Hrs.

X=87%

X=88%
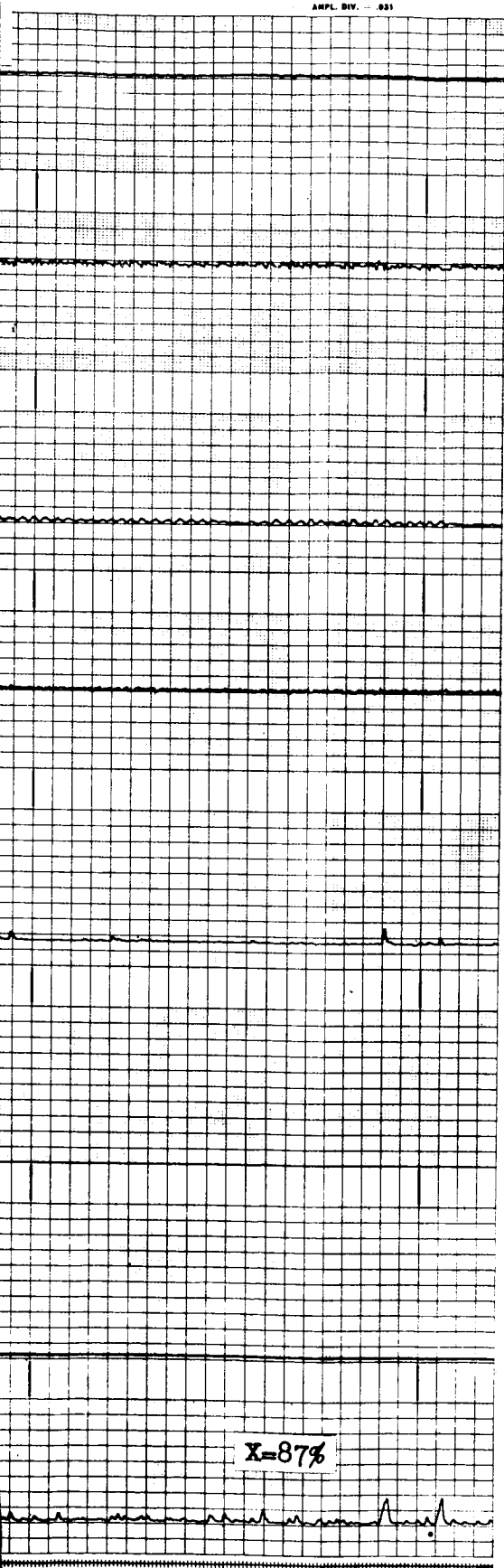
1 mark/sec
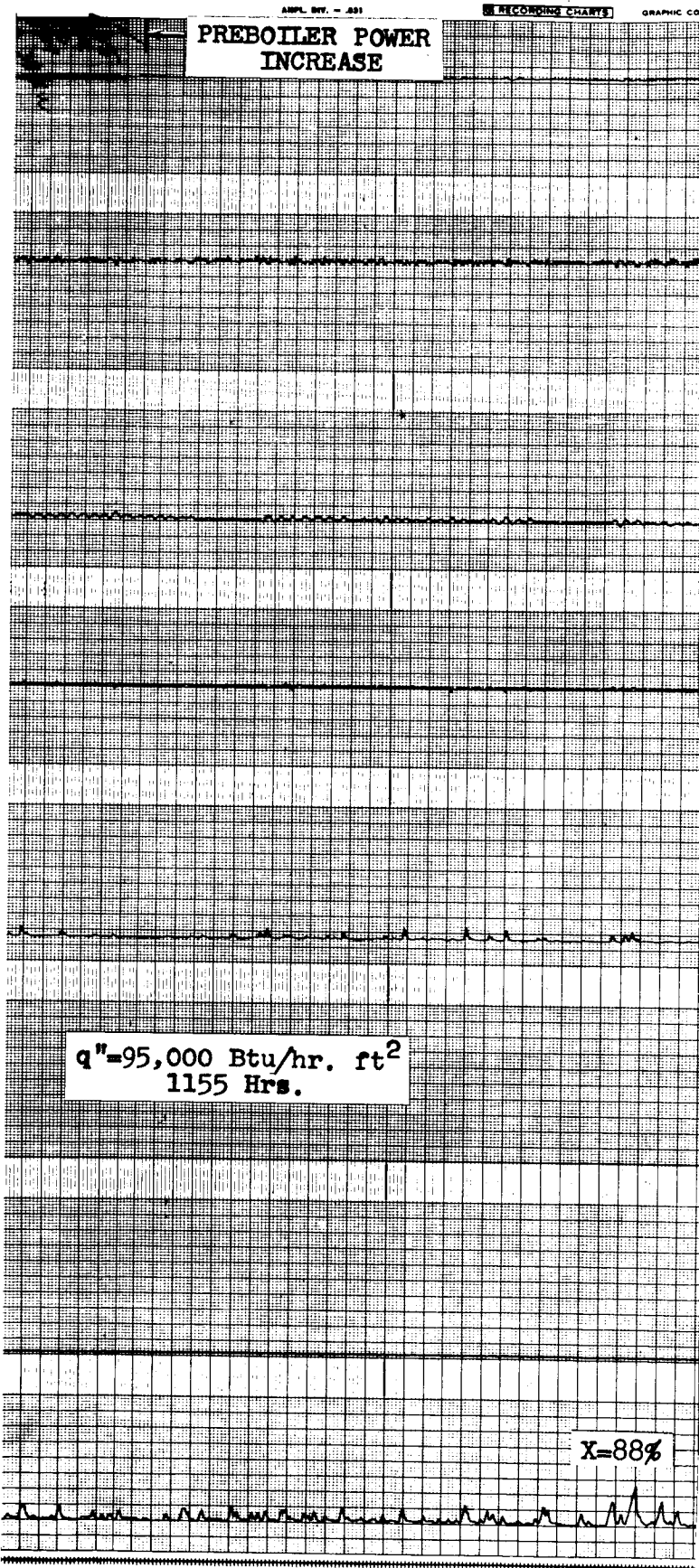
Figure 13.   Recorder Chart Showing the Critica
Transition Boiling and Film Boilin

PREBOILER POWER
INCREASE

PREBOILER POWER
INCREASE

X=82%

X=85%

q"=94,000 Btu/hr. ft^2
1214 Hrs.

X=93%

FILM BOILING
X=96%
T=2490°F
h=258 Btu/hr. ft^2
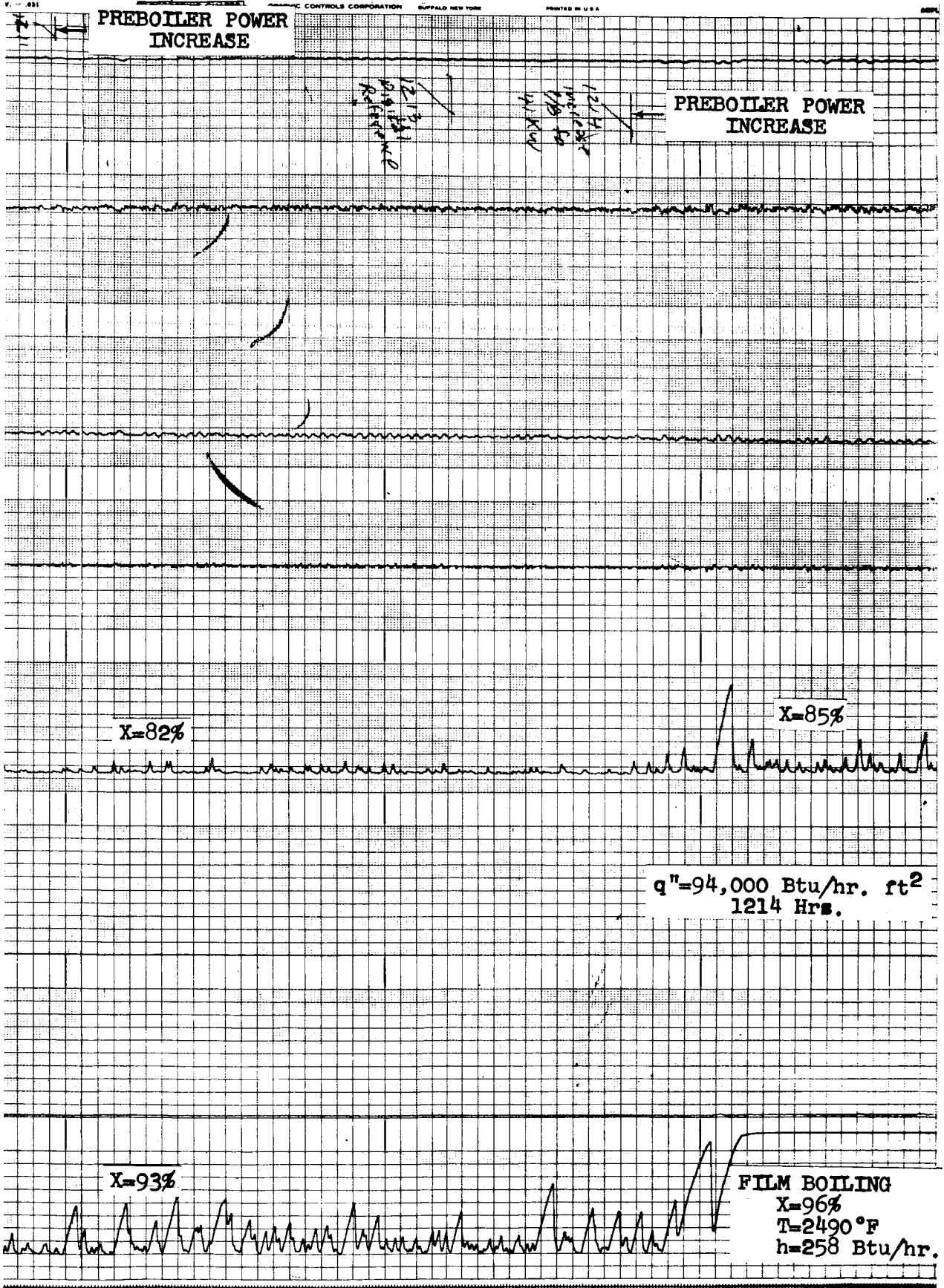
Test Section I.D. = 0.423 inch
T_{sat} = 2104°F

1 Heat Flux Condition,
g - 100KW Loop (3/31/65).

G=47.6 lb/sec ft.^{2}

$\triangle P$ = 36.9 psi — Pressure Upstream of Orifice

$\triangle P$ = 37.2 psi — Pressure Downstream of Orifice

$\triangle L$ = 1.41 in. — Dump Tank Level

Flow Rate G = 47.6 lb/sec ft^2

0

$\triangle T$ = 250°F — Test Section Wall Temp. Midpoint

$\triangle T$ = 250°F — Fluid Temp. at Test Section Outlet

$\triangle T$ = 250°F — Test Section Wall Temp. 2" From Outlet

Test Section Power Increase

q'' = 37,000 Btu/hr ft^2

q'' = 24,500 Btu/hr ft^2

x = 80%   x = 83%

Time 1 Mark/sec
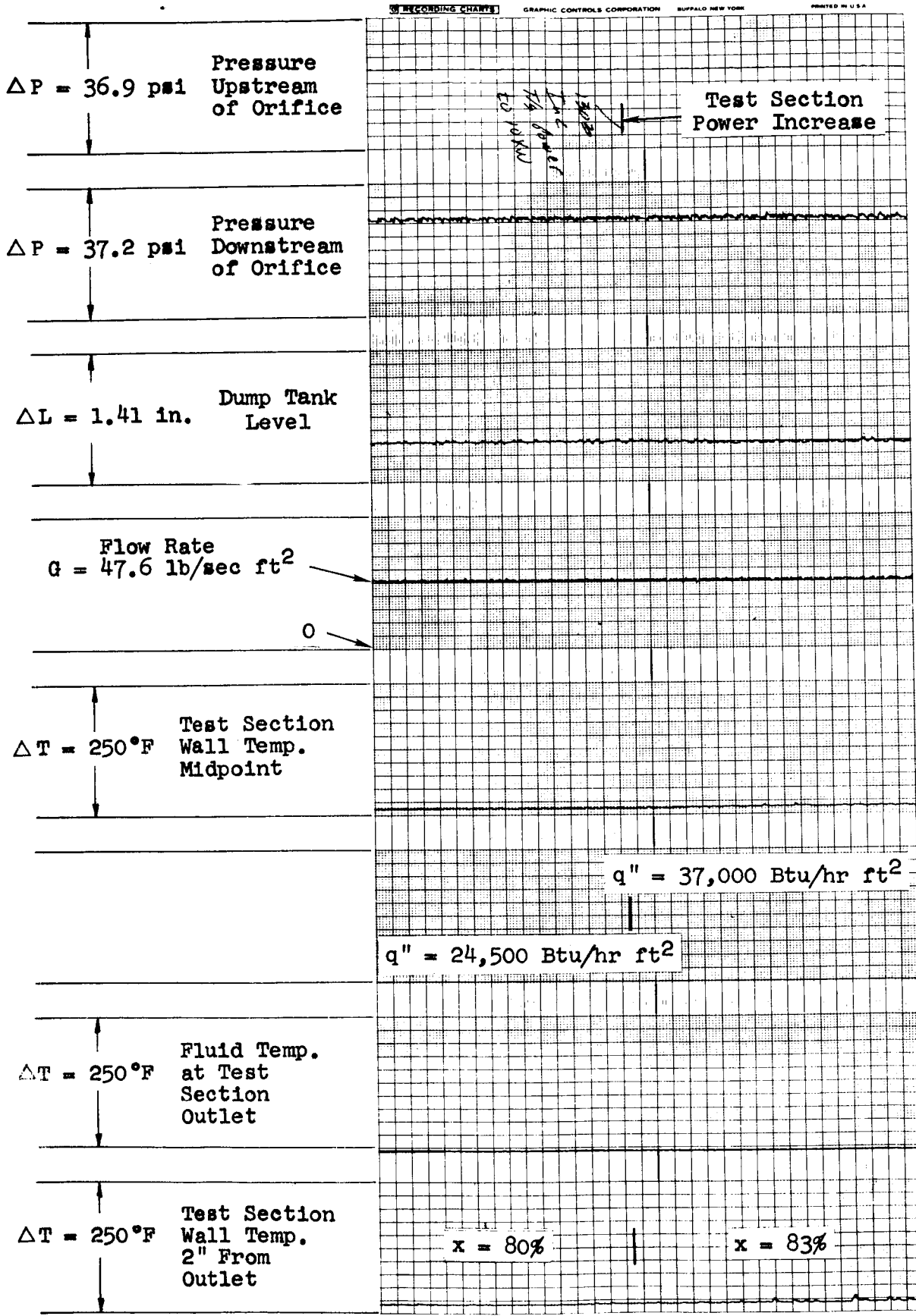
Test Section I.D. = .423 in. - No Insert
T_{sat} = 2105°F
G = 47.6 lb/sec ft^2

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Figure 14a. Recorder Chart
100KW Loop.

2

Preboiler Power Increase

Preboiler Power Increase

80%   x = 83%

x = 83%   x = 85%

$q'' = 50,300$ Btu/hr ft^2
1328 Hrs

$q'' = 49,000$ Btu/hr ft^2
1331 Hrs

= 86%   x = 89%

x = 89%   x = 91%

Showing Changes in Boiling Regime -

GRAPHIC CONTROLS CORPORATION

$\Delta P = 36.9$ psi | Pressure Upstream of Orifice

Preboiler Power Increase

$\Delta P = 37.2$ psi | Pressure Downstream of Orifice

$\Delta L = 1.41$ in. | Dump Tank Level

Flow Rate
$G = 47.6$ lb/sec ft^2

0

$\Delta T = 250°F$ | Test Section Wall Temp. Midpoint

x = 85%

x = 90%

q" = 49,000 Btu/hr ft^2
1342 Hrs

$\Delta T = 250°F$ | Fluid Temp. at Test Section Outlet

$\Delta T = 250°F$ | Test Section Wall Temp. 2" From Outlet

x = 91%

x = 96%

Test Section I.D. = 0.423 in. - No Insert
$T_{sat} = 2105°F$
$G = 47.6$ lb/sec ft^2

Time

Preboile
Incre

x = 95

x = 90%

3/31/... → q" = 49,000 Btu/hr ft²
1349 Hrs

(Δ

x = 96%
h = 228 Btu/hr ft² °F

x =
h =

1 Mark/sec
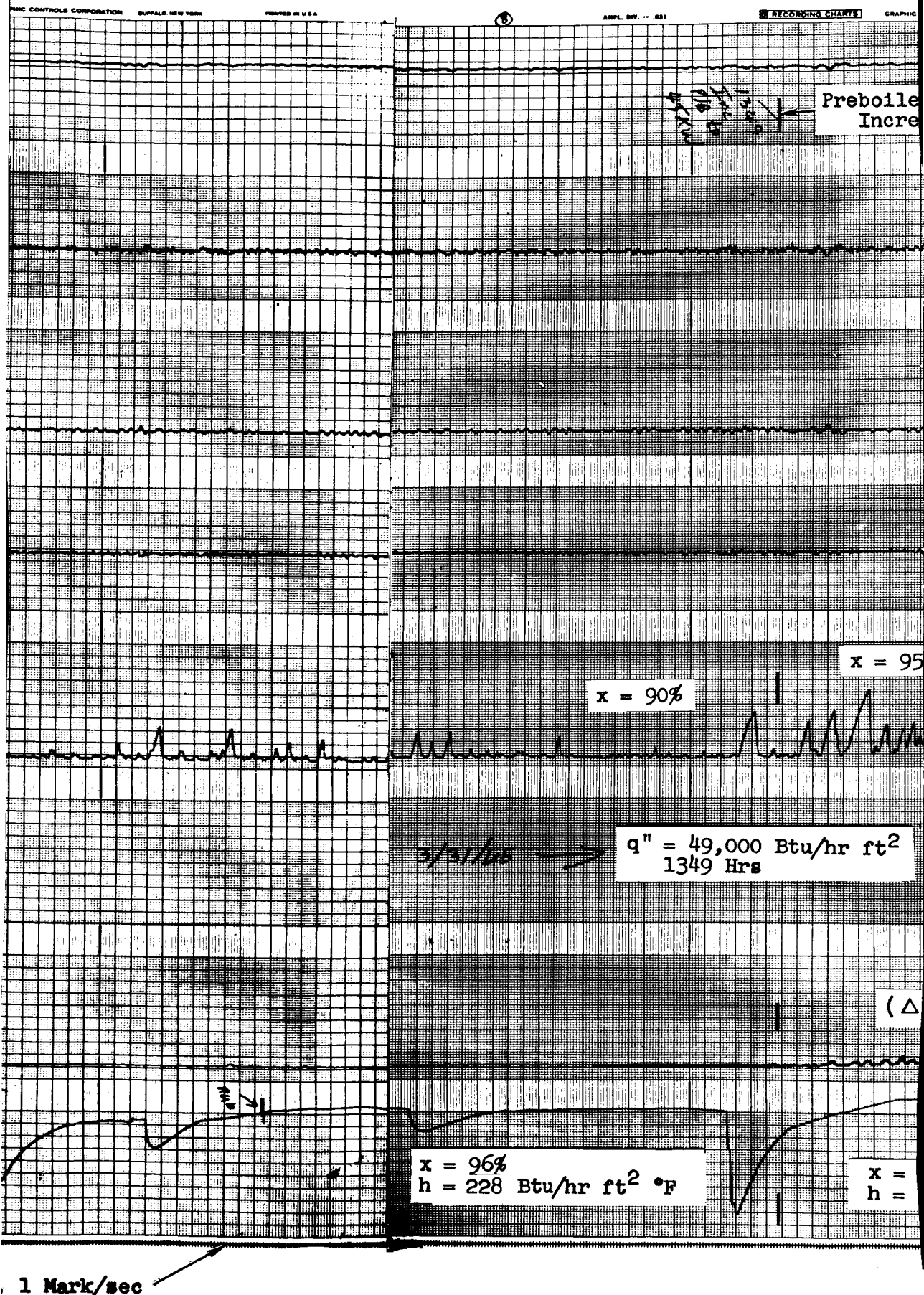
Figure 14b.   Recorder Chart Showing Changes in Boiling Regime -
100KW Loop (continued)

3

r Power
ase

Preboiler Power
Increase

%

$\Delta T = 500°F$

x = 99%

x = 100%

$q'' = 54,300 \text{ Btu/hr ft}^2$
1414 Hrs

$(\Delta T)_{SH} = 120°F$

$T)_{SH} = 25°F$

$(\Delta T)_{SH} = 200°F$

101%
194 Btu/hr ft² °F

$\Delta T = 500°F$

x = 105%

x = 106%

$\Delta P = 36.9$ psi — Pressure Upstream of Orifice

$\Delta P = 37.2$ psi — Pressure Downstream of Orifice

$\Delta L = 1.41$ in. — Dump Tank Level

Flow Rate
G = 47.6 lb/sec ft^2

0

$\Delta T = 500°F$ — Test Section Wall Temp. Midpoint

Preboiler Power Decrease

x = 100%   x = 98%

$q'' = 50,700$ Btu/hr ft^2
1420 Hrs

$\Delta T = 250°F$ — Fluid Temp. at Test Section Outlet

$(\Delta T)_{SH} = 75°F$

$(\Delta T)_{SH} = 125°F$

$\Delta T = 500°F$ — Test Section Wall Temp. 2" From Outlet

x = 106%   x = 104%
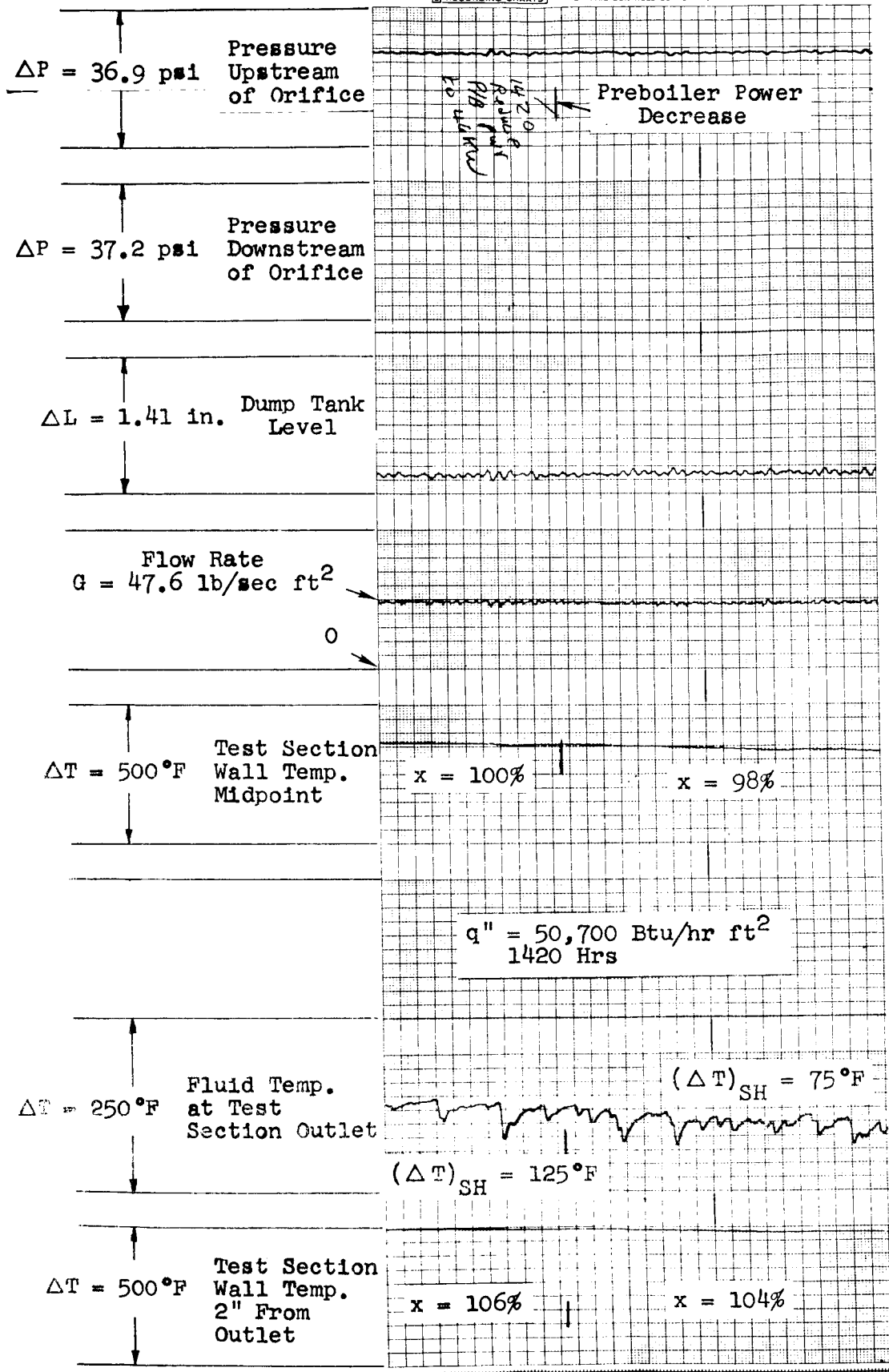
Test Section I.D. = 0.423 in. - No Insert
$T_{sat} = 2105°F$
G = 47.6 lb/sec ft^2
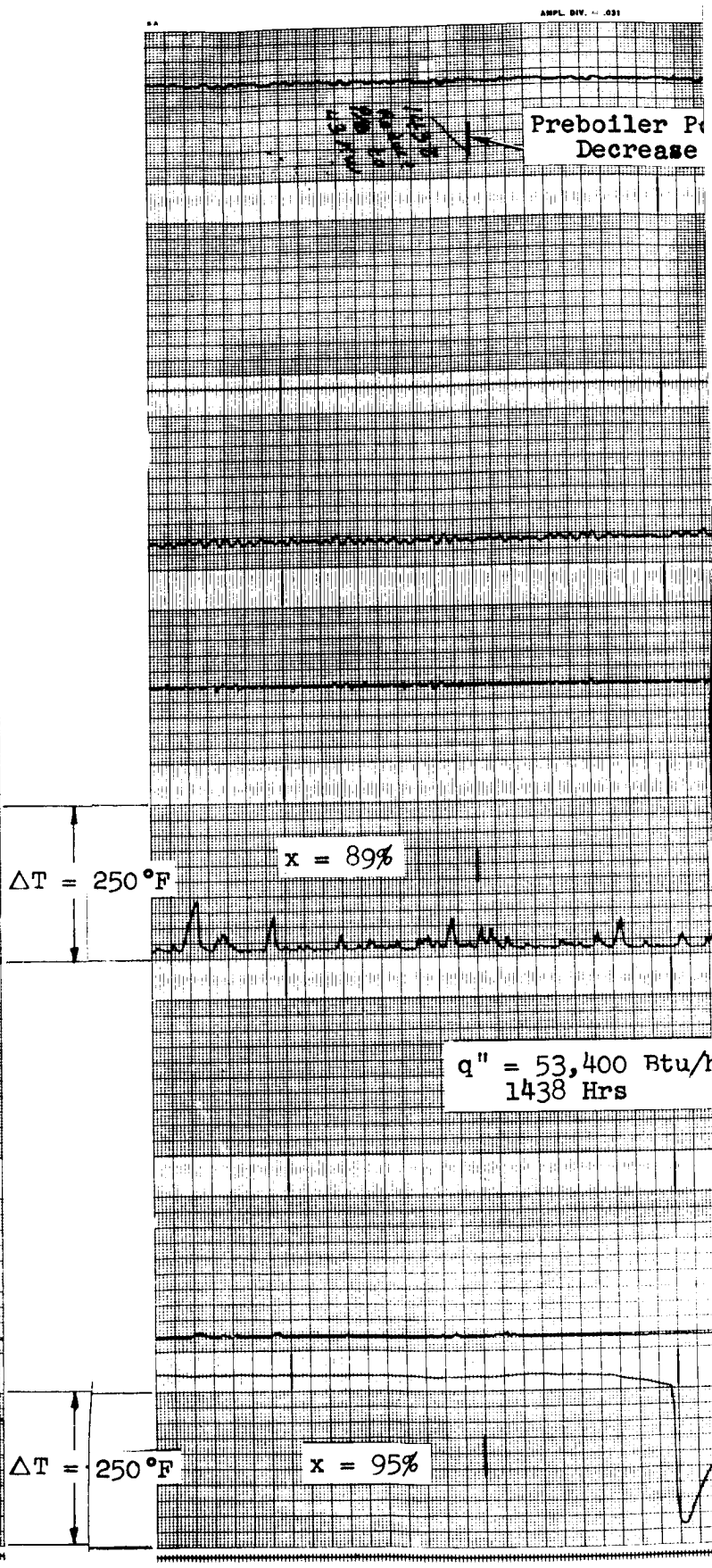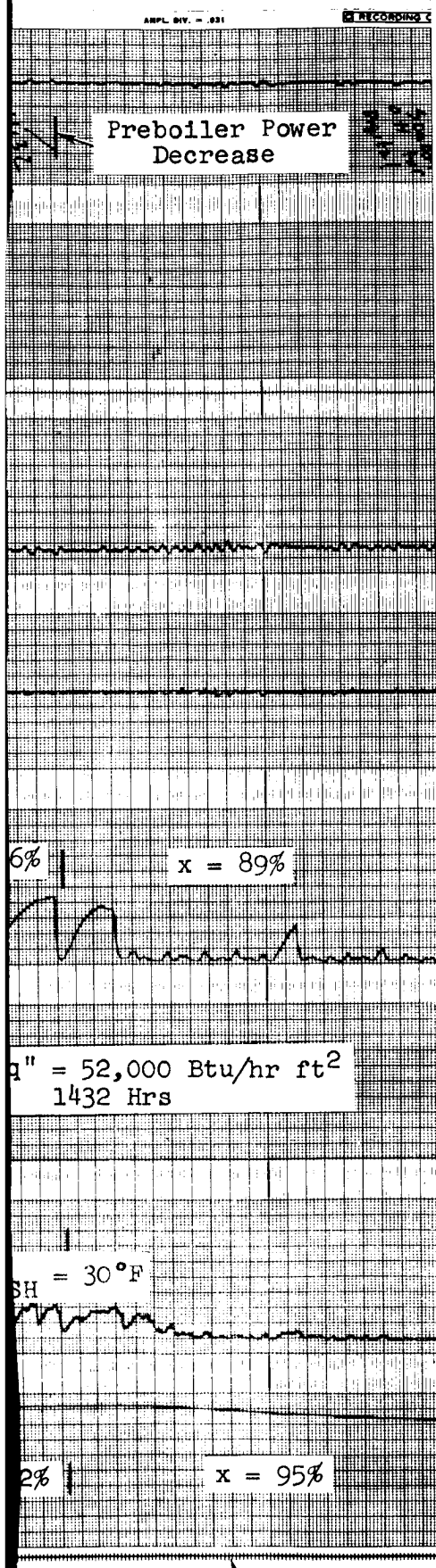
Figure 14c. Recorder Chart Showing Changes in Boiling
              100KW Loop (continued)

ower

x = 87%

r ft²

Regime -

Preboiler Power
Decrease

x = 81%   x = 78%

q" = 50,500 Btu/hr ft²
1455 Hrs

x = 87%   x = 84%

x = 93%
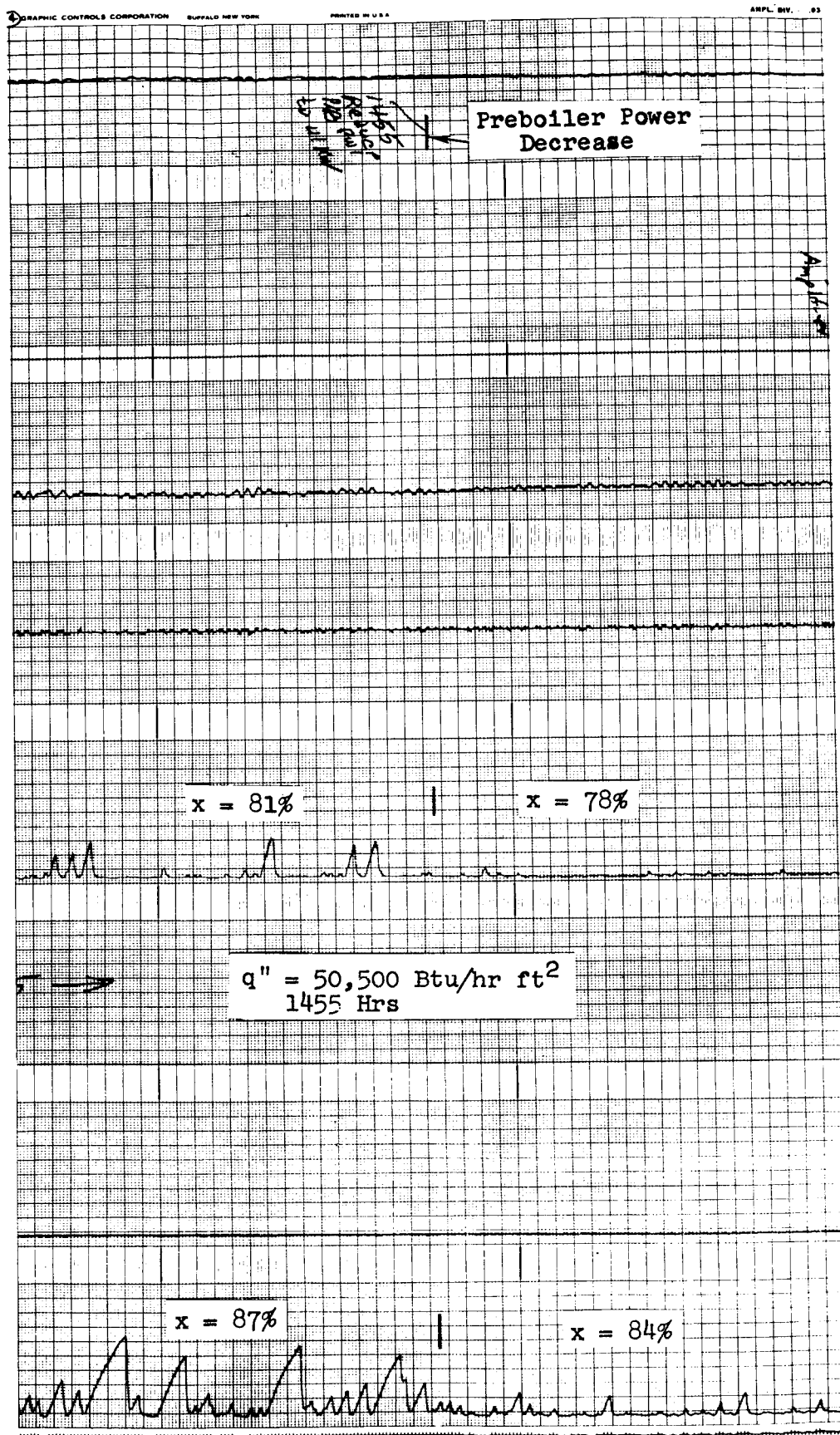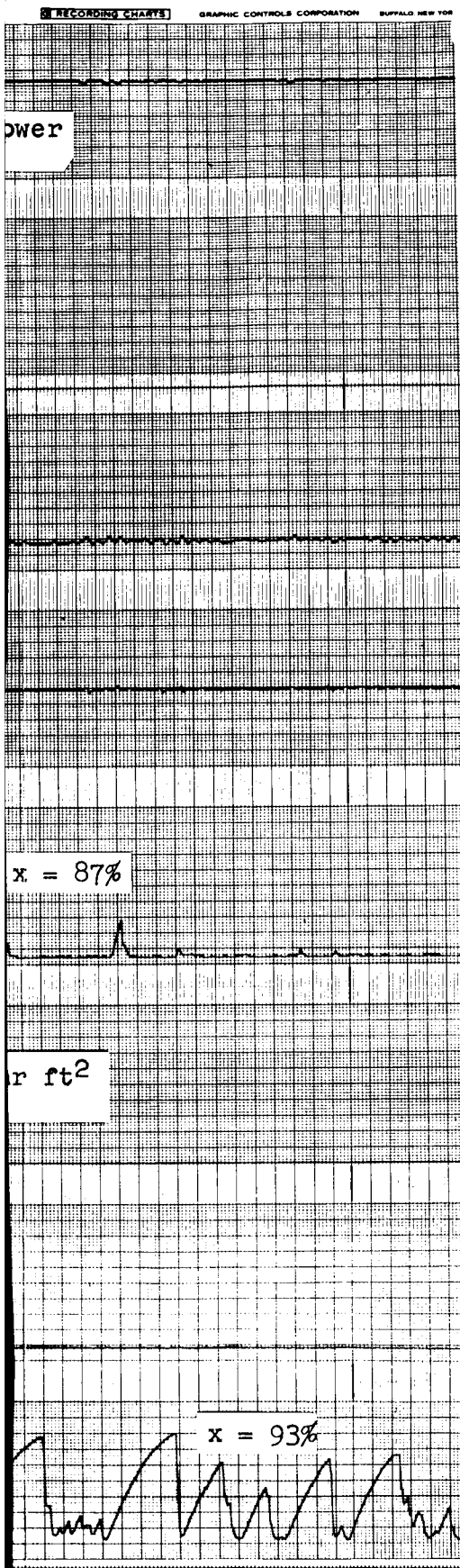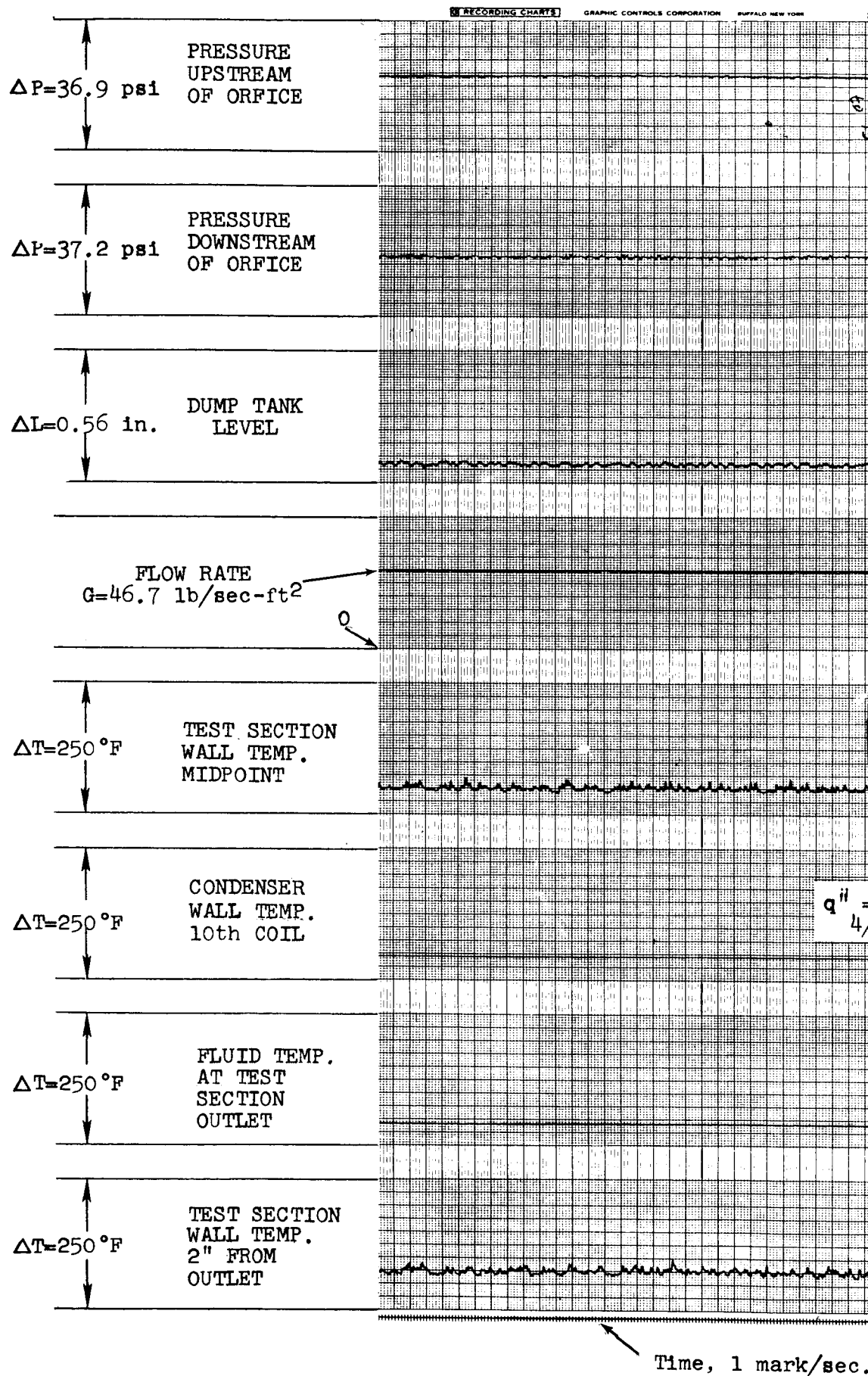
Figure 15a. Recorder Chart Showing the On
Flux Condition - 100KW Loop (

PREBOILER POWER
INCREASE

211,000 Btu/lb, ft^2
1/65 (1332 Hrs.)

AUTOMATIC TEST SECTION
POWER TRIP
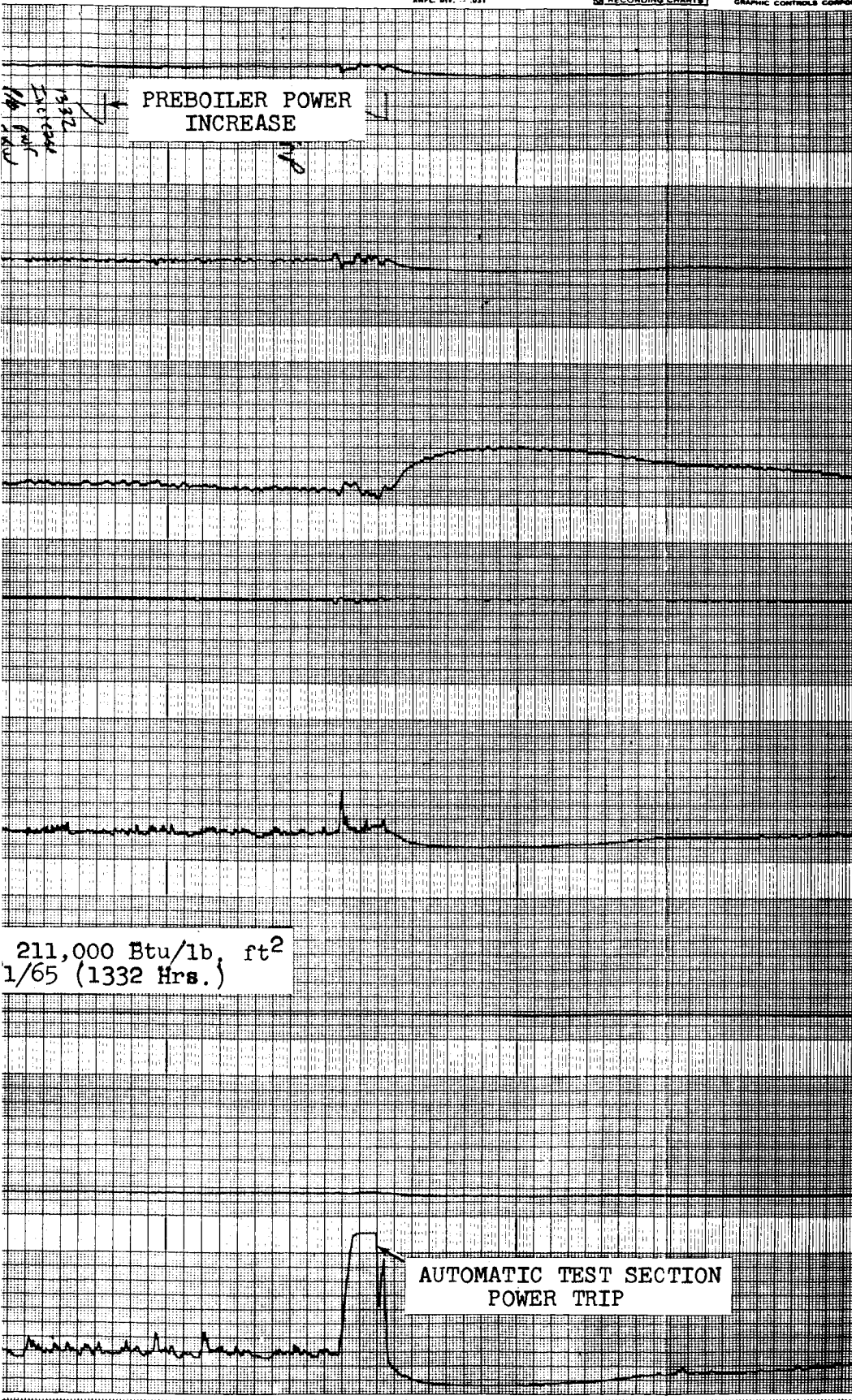
Test Section I.D. = 0.423 in.
T_{sat} = 2105°F
G = 46.7 lb/sec. ft^2
q_c'' = 211,000 Btu/hr. ft^2
X_c = 59%

set of the Critical Heat
/1/65).

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ΔP=36.9 psi   PRESSURE UPSTREAM OF ORIFICE

ΔP=37.2 psi   PRESSURE DOWNSTREAM OF ORIFICE

ΔL=0.56 in.   DUMP TANK LEVEL

FLOW RATE $G=46.5$ lb/sec-ft^2

0

ΔT=250°F   TEST SECTION WALL TEMP. MIDPOINT

ΔT=250°F   CONDENSER WALL TEMP. 10th COIL

$q''=214,000$ Btu/lb ft^2
4/1/65

ΔT=250°F   FLUID TEMP. AT TEST SECTION OUTLET

ΔT=250°F   TEST SECTION WALL TEMP. 2" FROM OUTLET

TIME, 1 ma

-126-
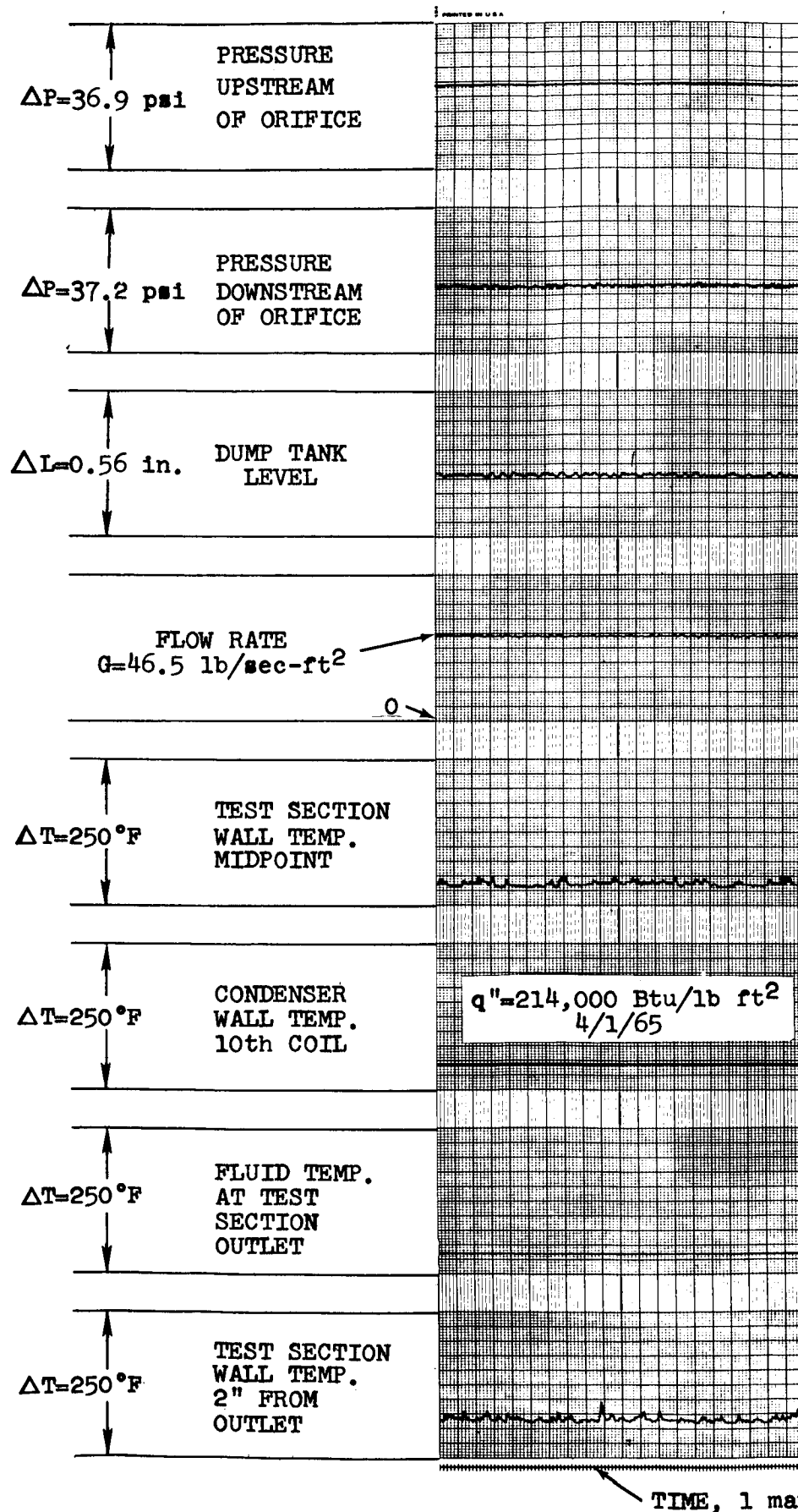
Figure 15b.   Repeat of Critical Heat Flux Point 100KW Loop (4/1/65).

AUTOMATIC TEST SECTION
POWER TRIP

/sec.
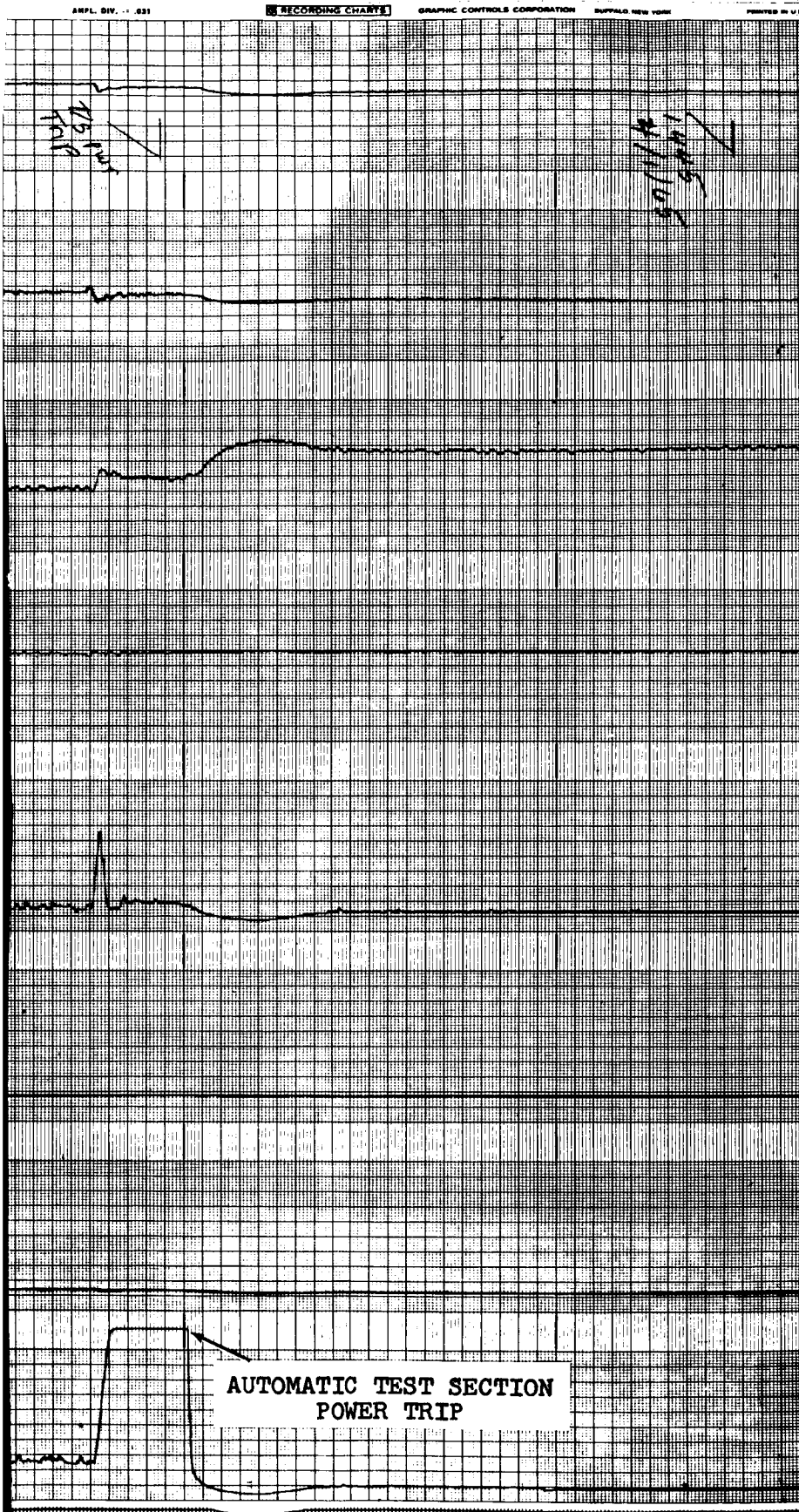
own in Figure 15a -

TEST SECTION I.D. = 0.423 in.
T_{sat} = 2106°F
G = 46.5 lb/sec-ft^2
q_c'' = 214,000 Btu/lb
X_c = 61%
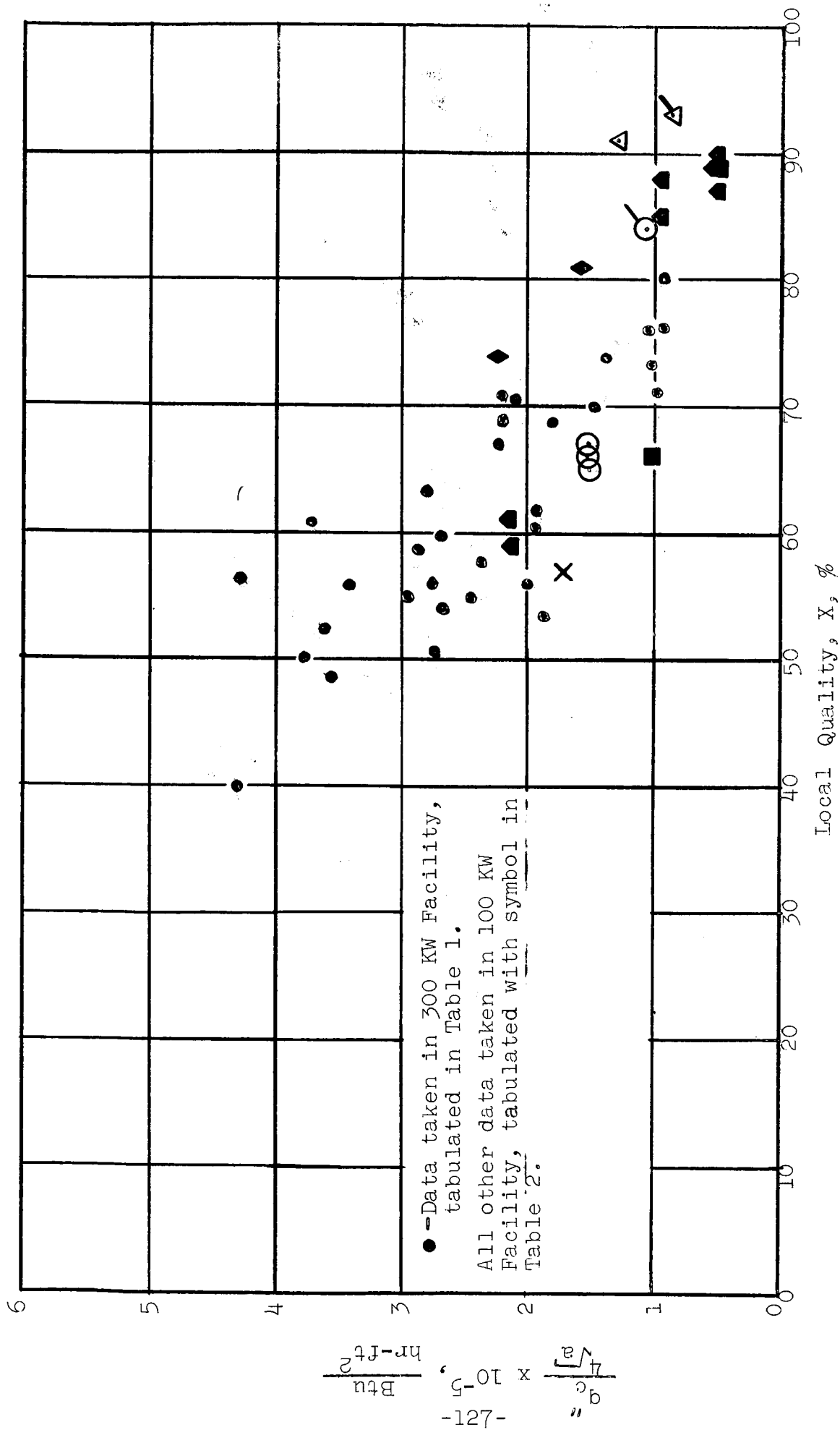
Figure 16. Comparison of Critical Heat Flux Data from the 100 KW and 300 KW Facilities
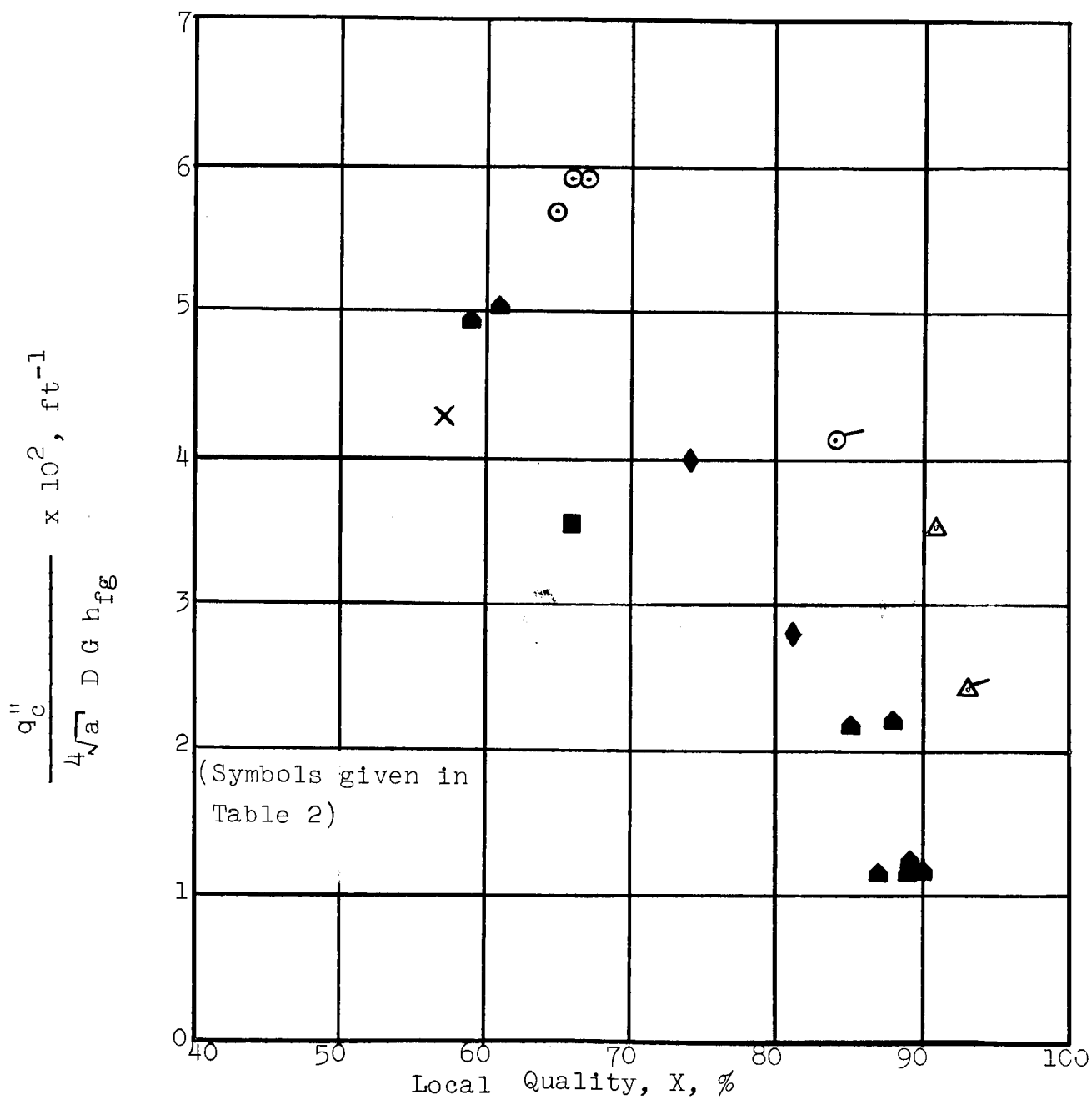
Figure 17.   Critical Heat Flux Parameter
As a Function of Quality —
100 KW Loop
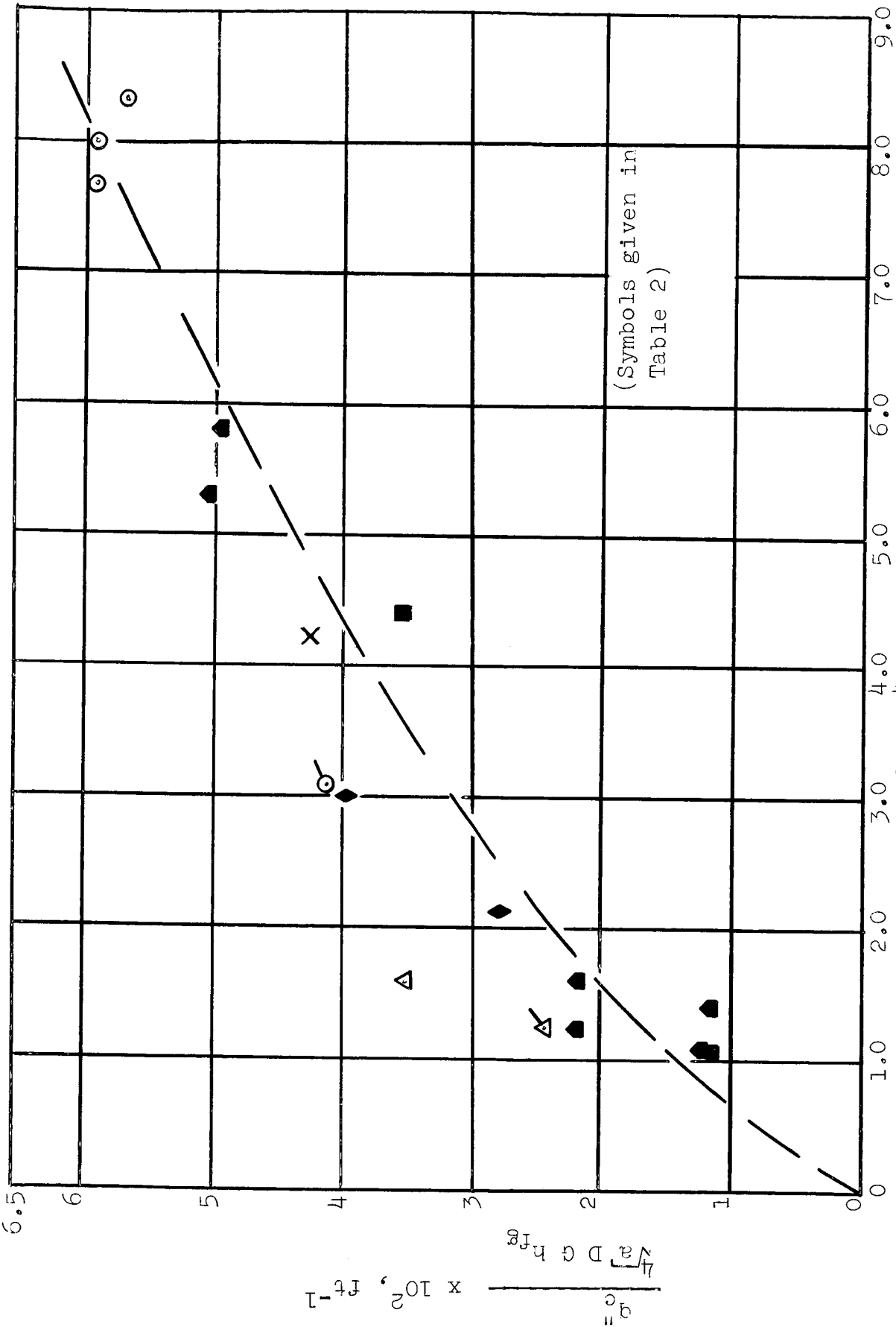
Figure 18. Critical Heat Flux Parameter as a Function of Liquid Film Thickness -- 100 KW Loop
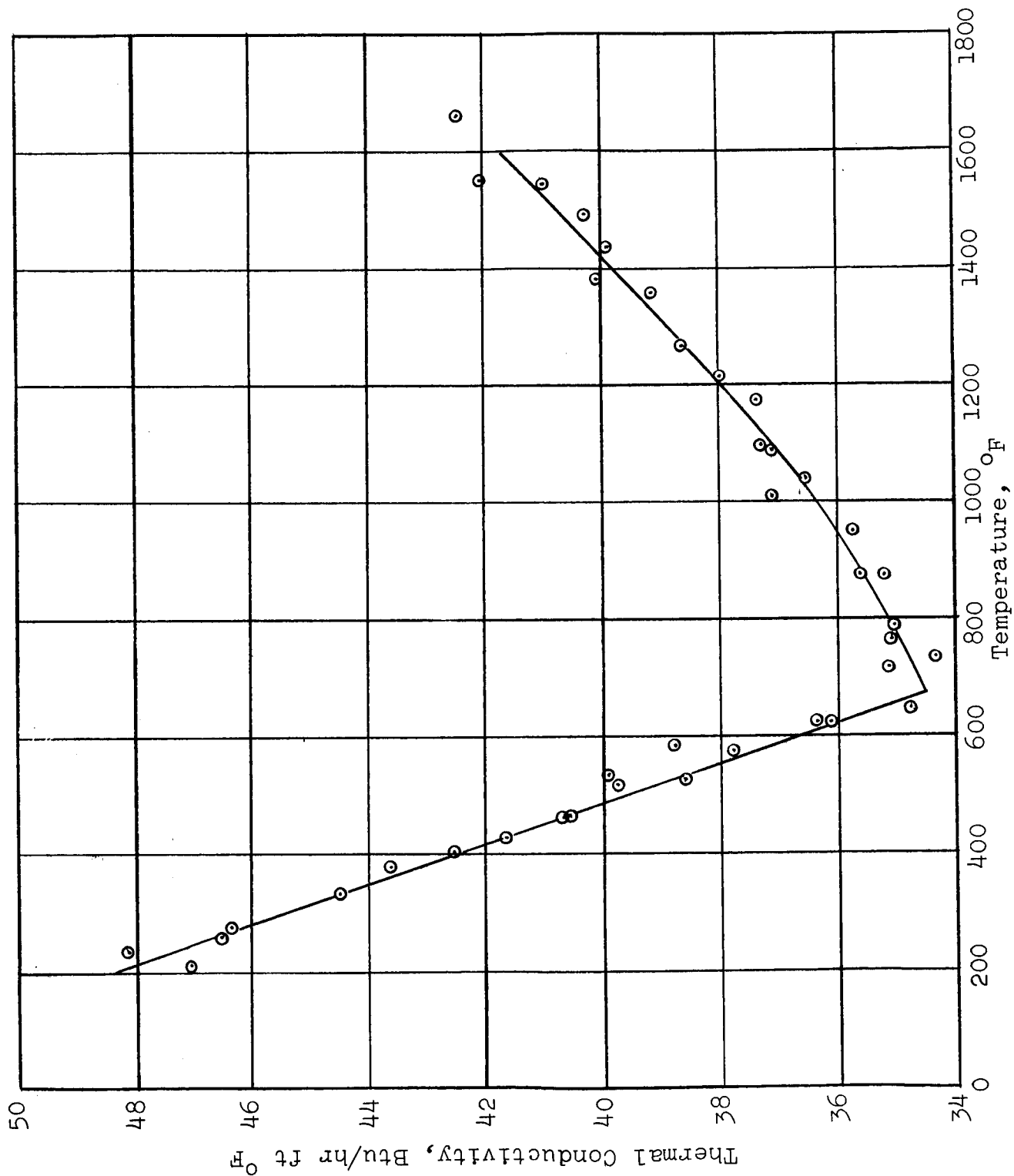
Figure 19   Thermal Conductivity of INCO Nickel 270 Material of
            50 KW Loop Condenser Tube

Test Period: December 1964

Geometry: 5/8-inch I.D. with Tapered Pin Insert
Range of total G, lbs/sec-ft^2:   3.7 to 19.3
Range of local T_{sat}, ^{O}F: 1198 to 1435

Measuring Station:	Top	Bottom
L/D, from inlet	10	46
Approximate local X, %	86	26
Range of local q", 10^5 Btu/hr-ft^2	0.50 to 2.3	0.64 to 3.0
Symbol in Figure 5:	O	●

Test Period: January 1965

Geometry: 3/8-inch ID plain Tube
Range of total G, lbs/sec-ft^2 3.8 to 36.1
Range of local T_{sat}, ^{O}F: 1143 to 1415

Measuring Station:	Top	Bottom
L/D, from inlet	21	75
Approximate local X, %	80	25
Range of local q", 10^5 Btu/hr-ft^2	0.29 to 2.8	0.29 to 3.2
Symbol in Figure 5:	Δ	▲
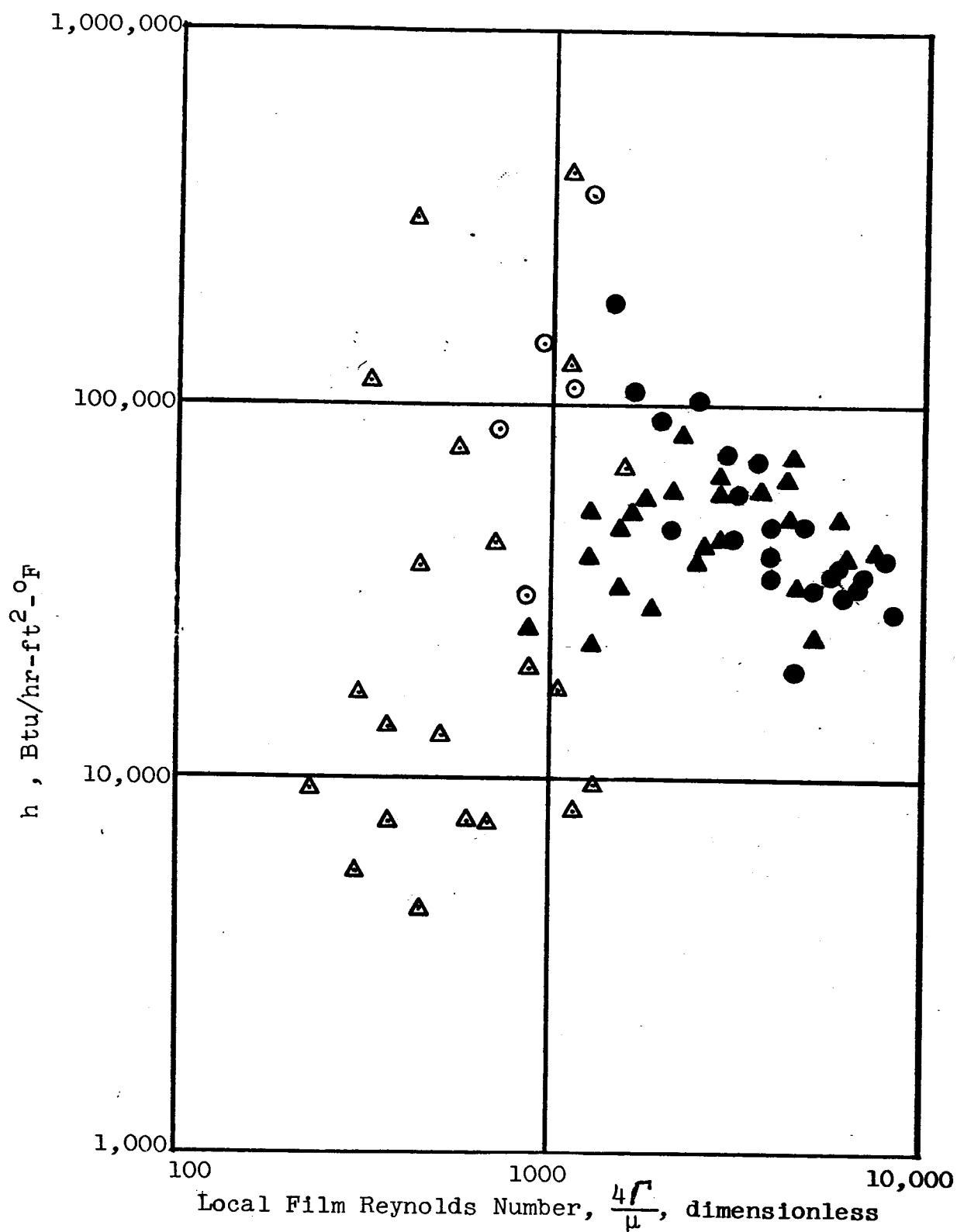
Figure 20. Local Condensing Heat Transfer Coefficients for
Potassium Vapor (50 KW Facility, 5/8-inch
Tube Tapered Pin Insert and 3/8-inch Tube
Without Insert)
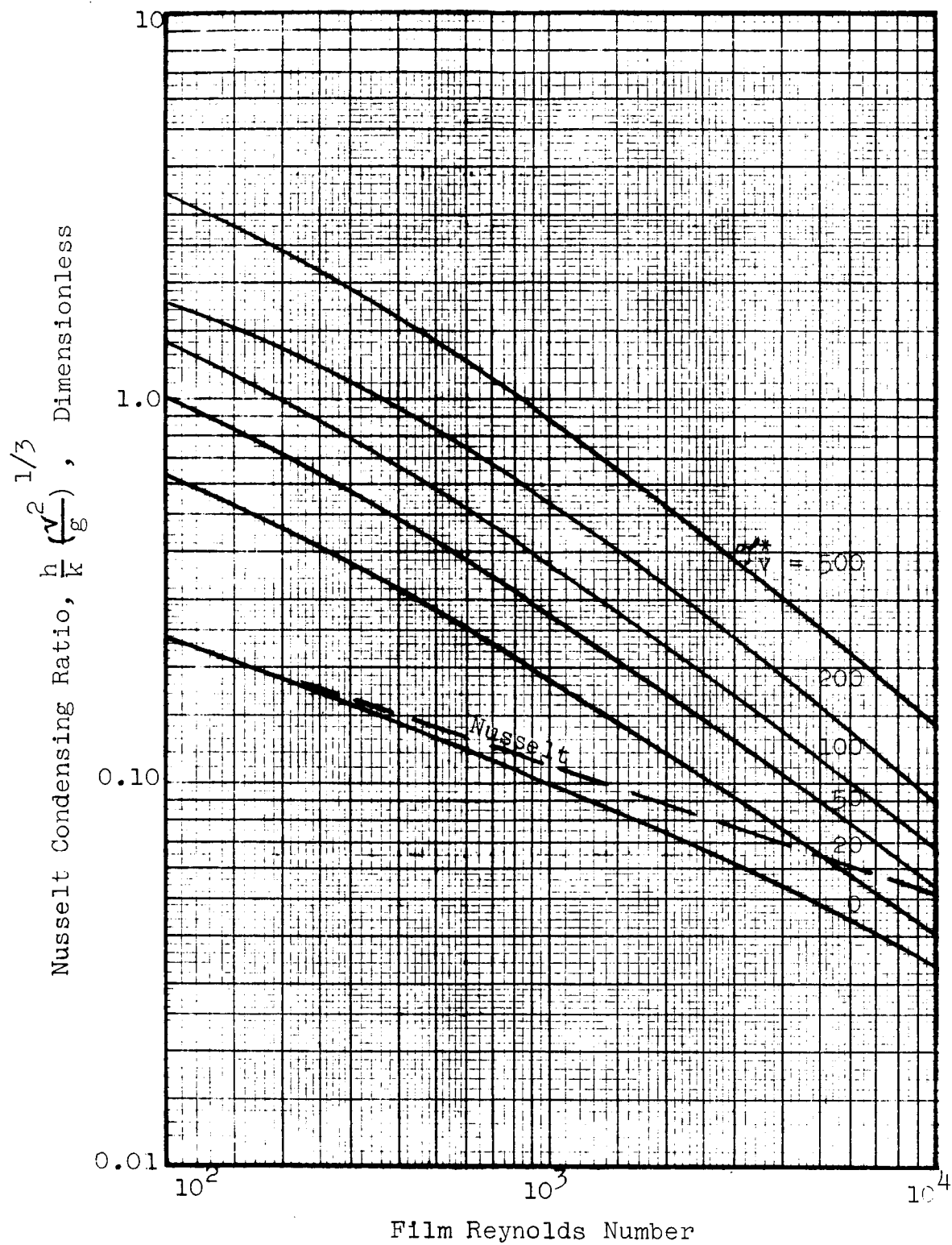
Figure 21. Predicted Nusselt Condensing Ratio
from Dukler Film Thickness
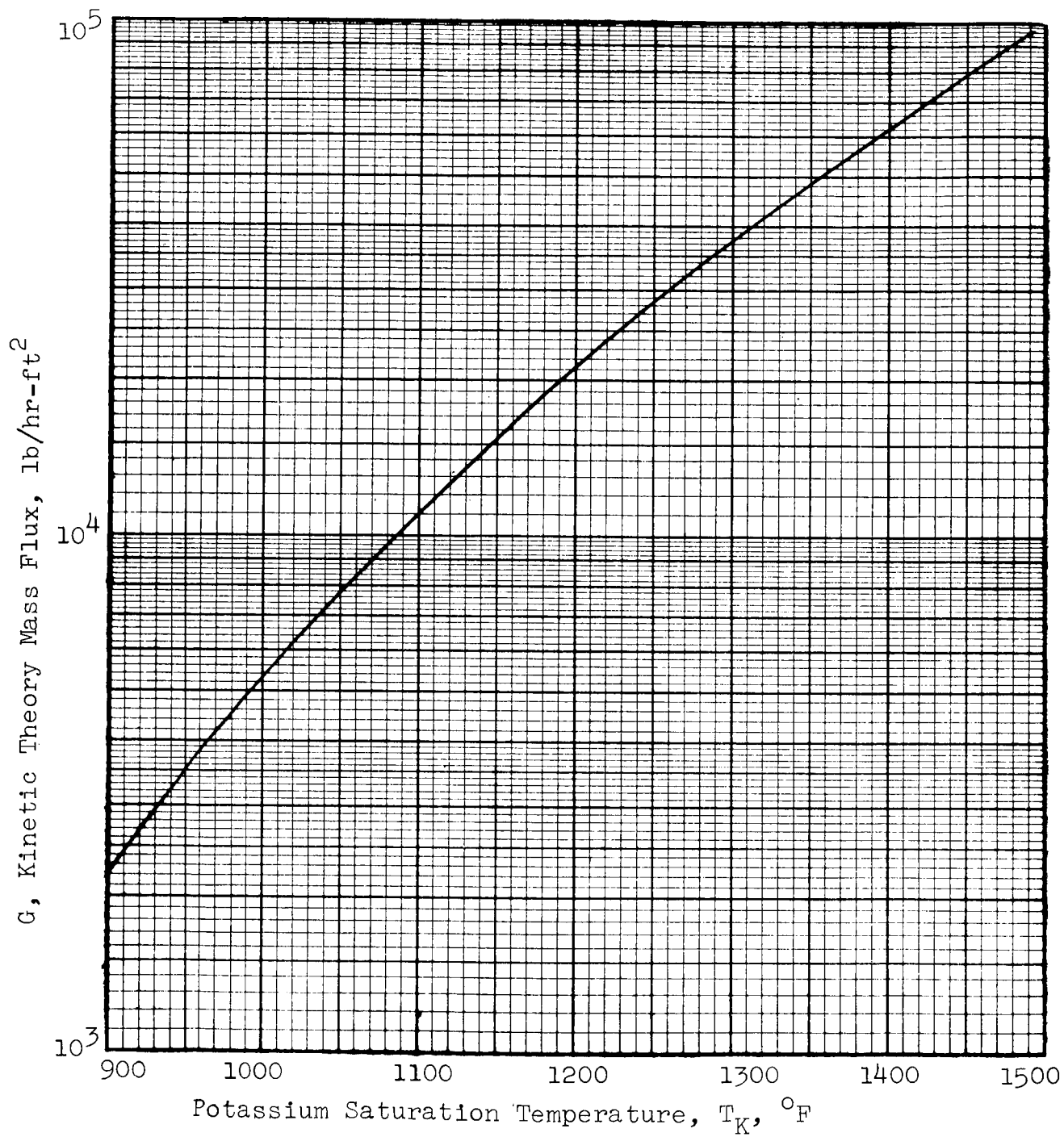
Figure 22. Kinetic Theory Mass Flux
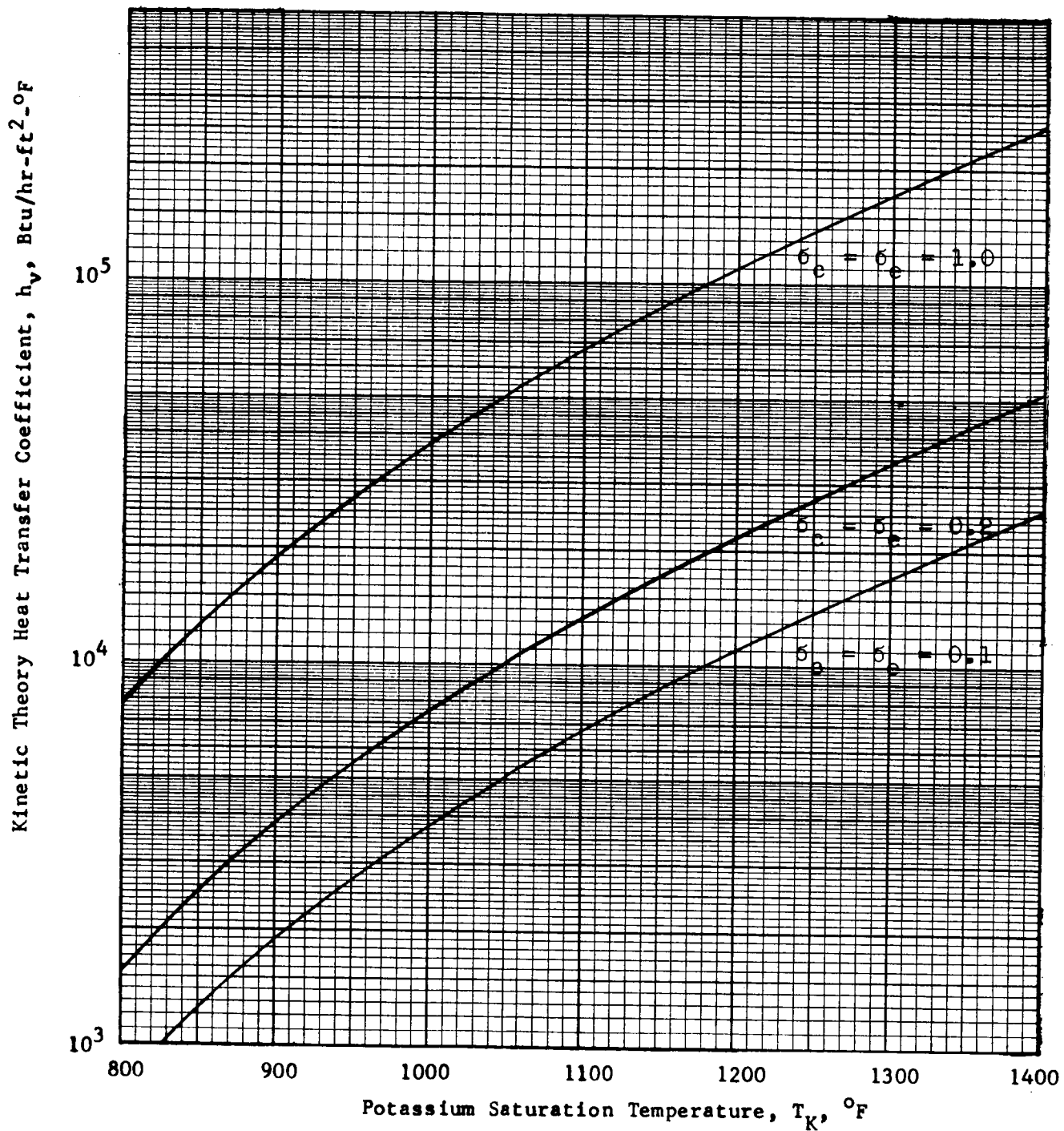
Figure 23. Kinetic Theory Heat Transfer Coefficient.
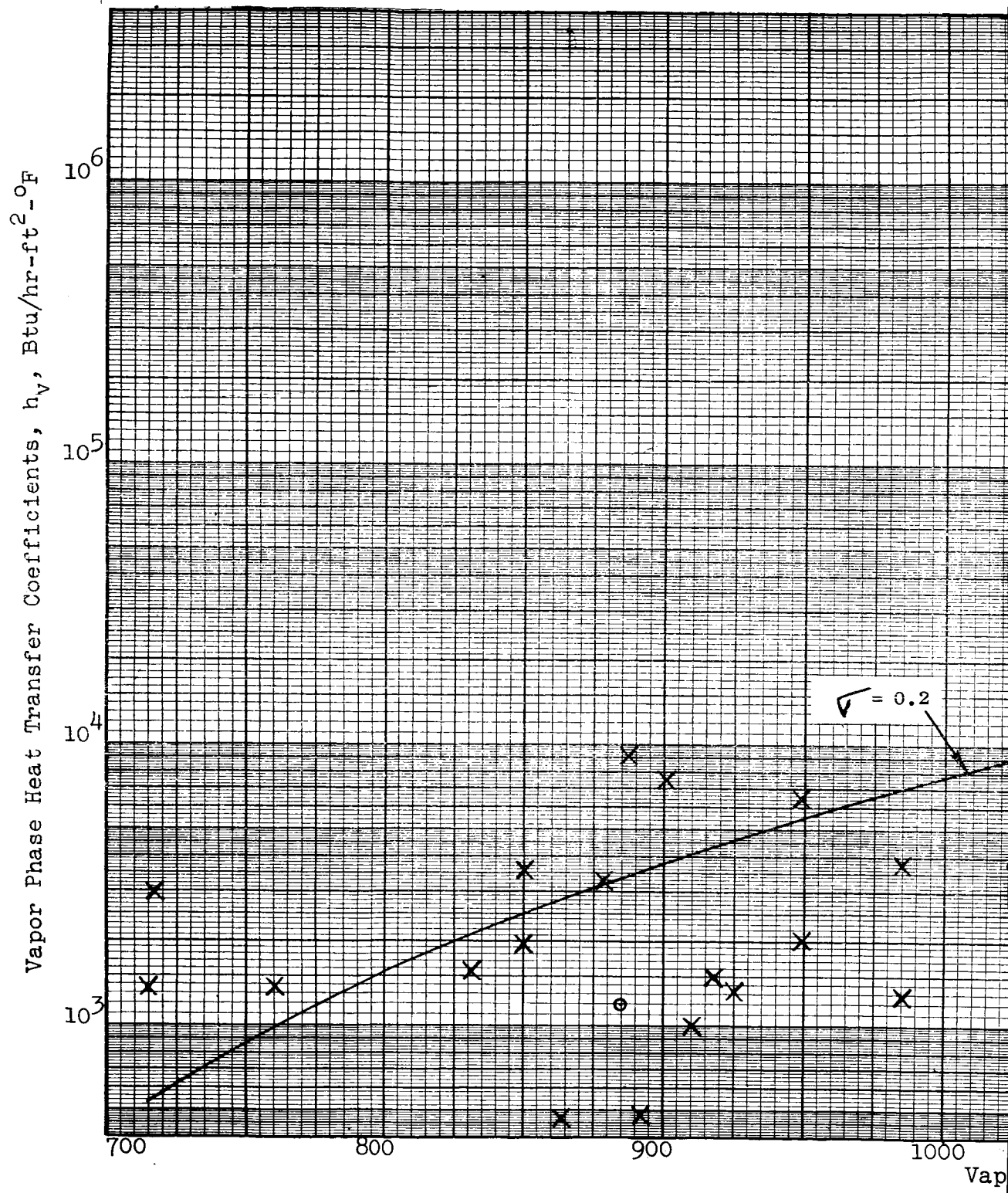
Figure 24. **Comparison of Vapor**
Prediction (Potassi

or Temperature, T_K, ^oF

Heat Transfer Results With Kinetic Theory
um)
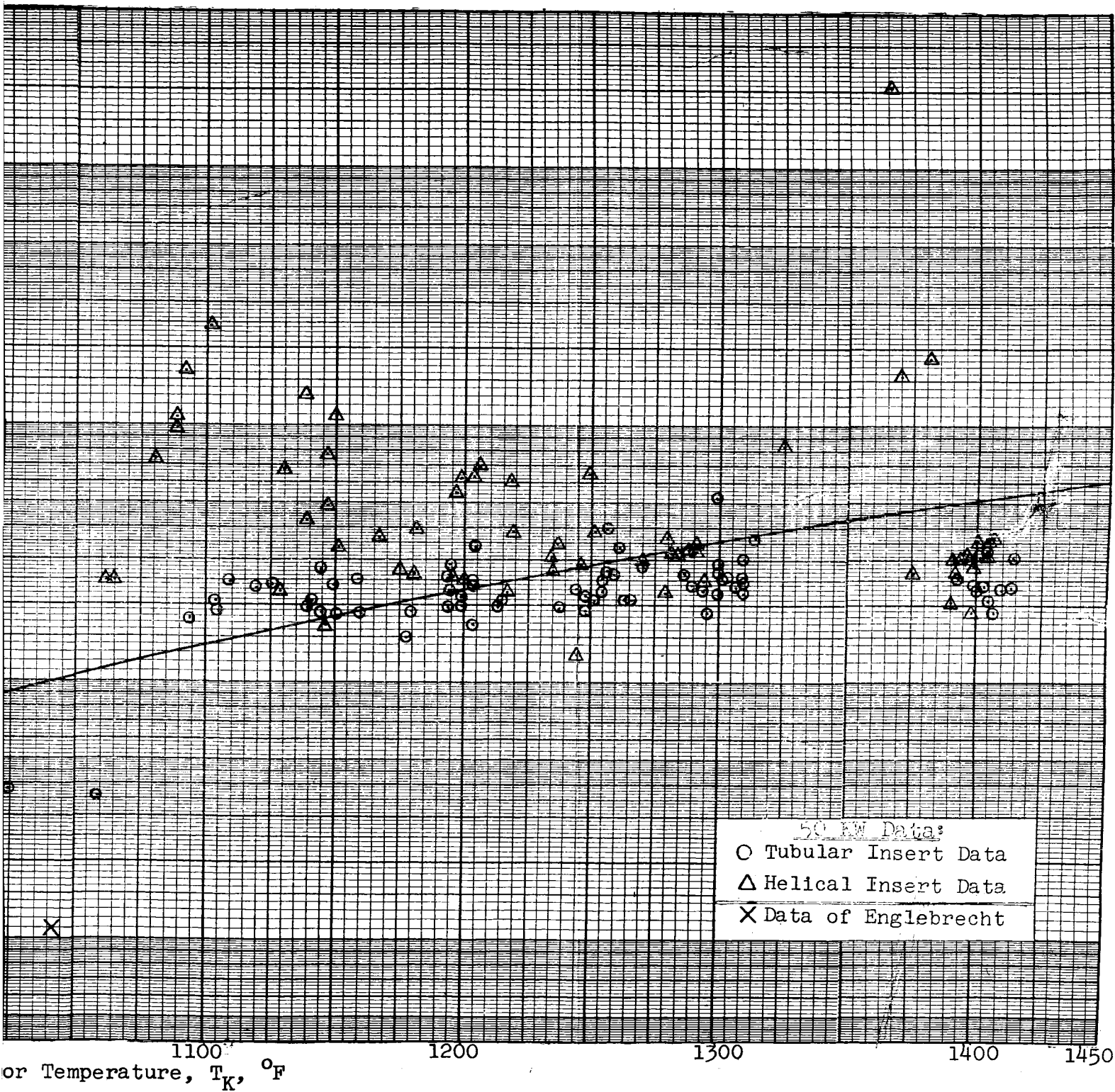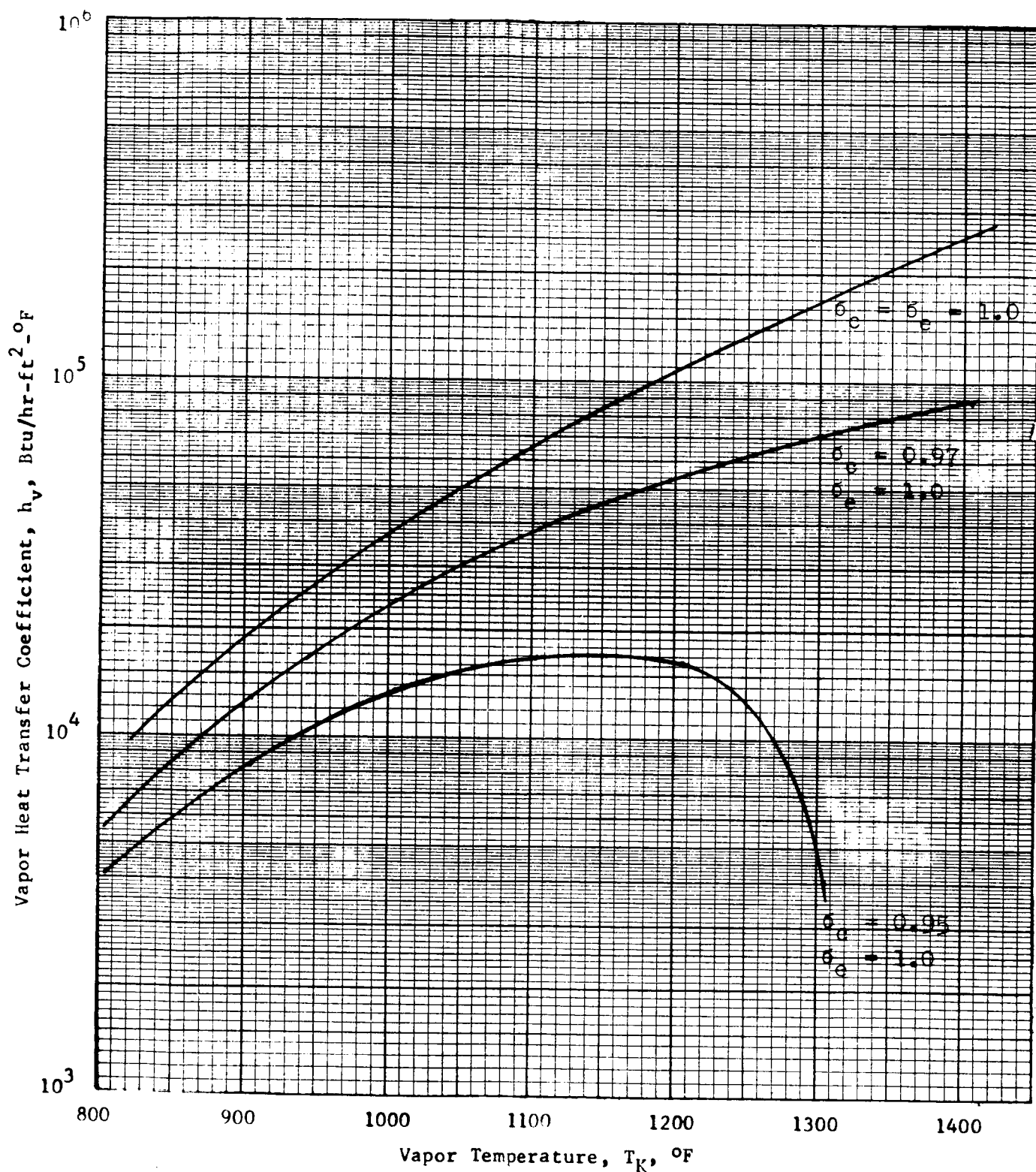
Figure 25. Kinetic Theory Heat Transfer Coefficient for $\sigma_e = 1.0$, $\delta_c \neq 1.0$
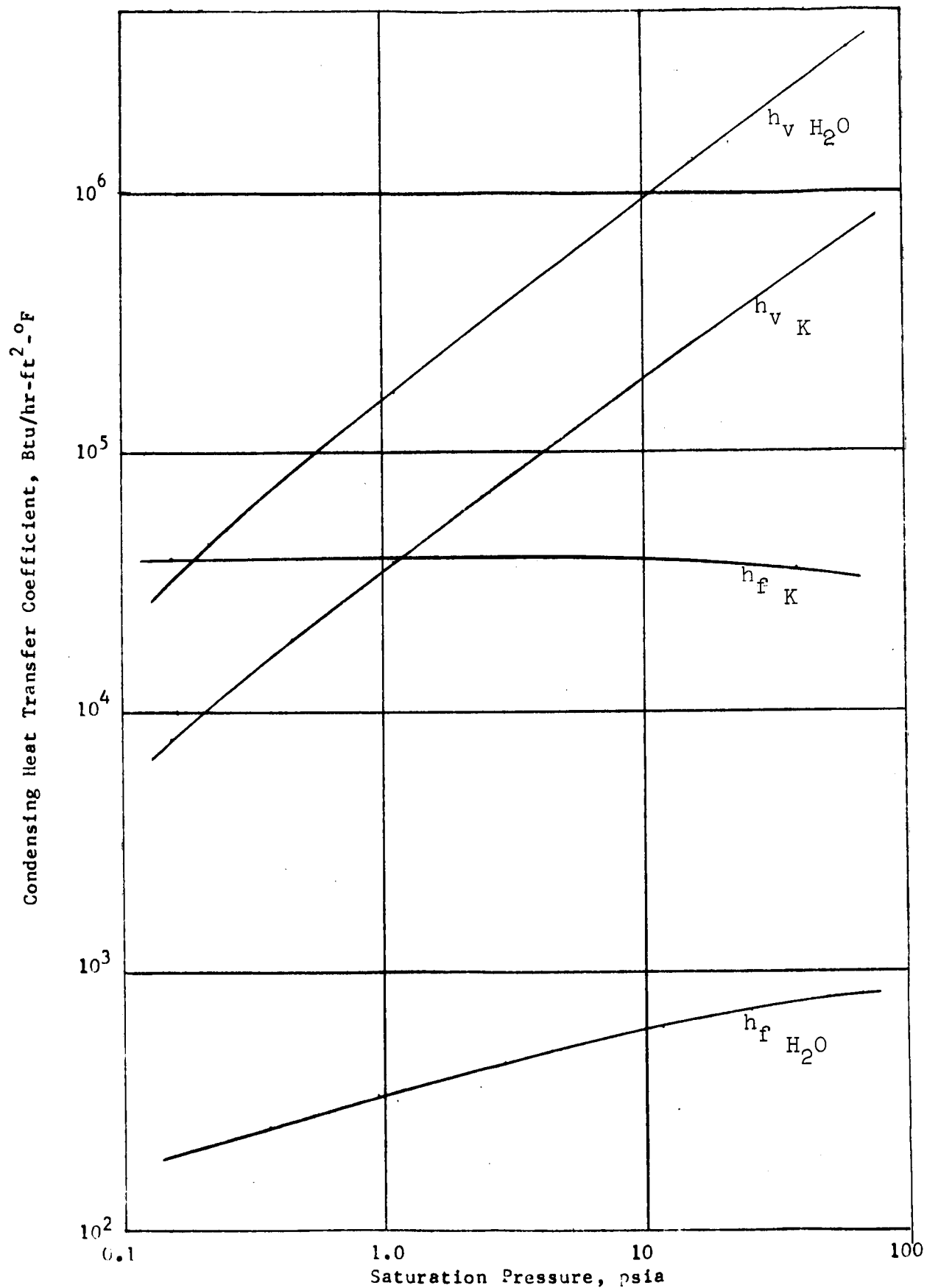
Figure 26. Comparison of Liquid Film and Vapor Heat Transfer Coefficients for Water and Potassium for $\sigma_c = \sigma_e = 1$.
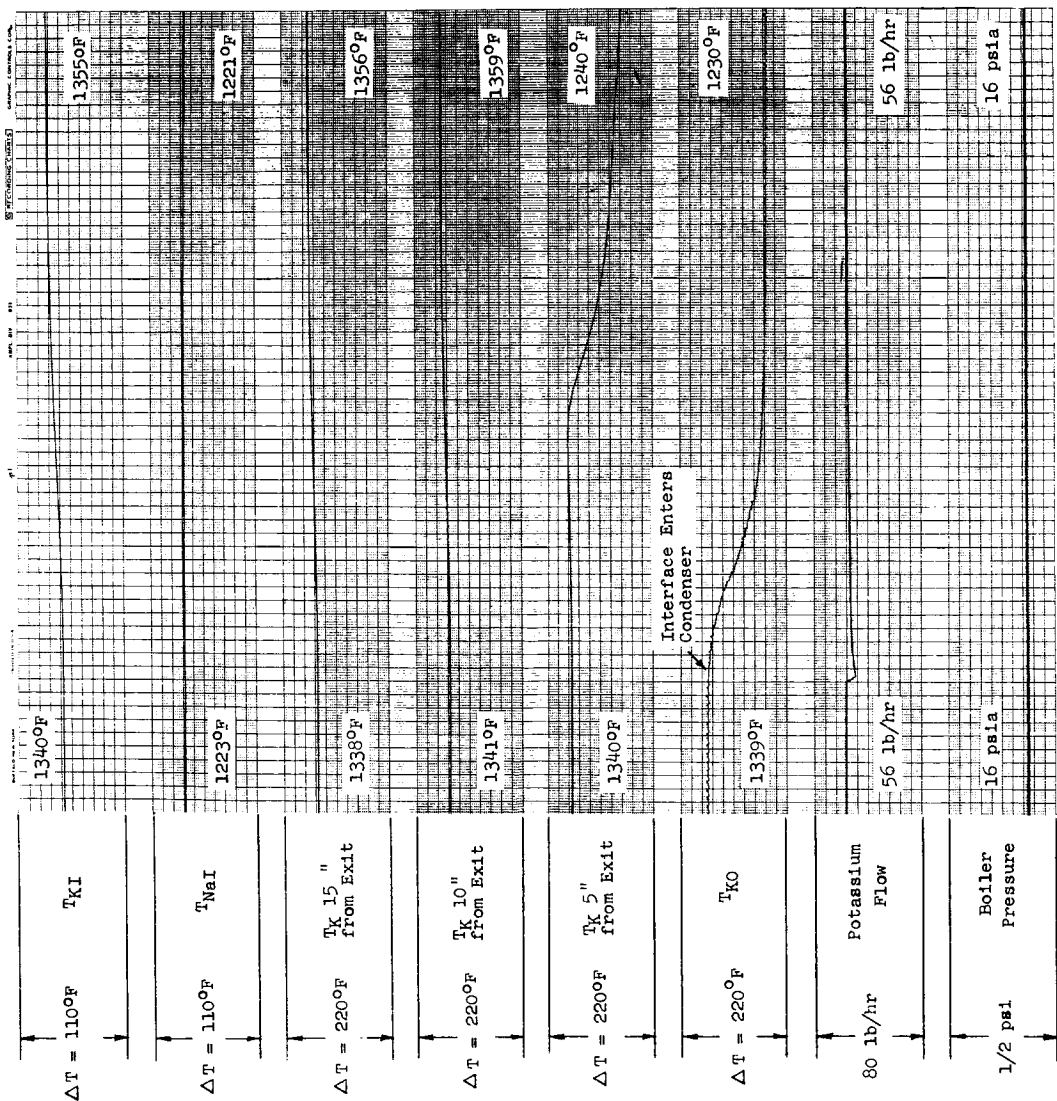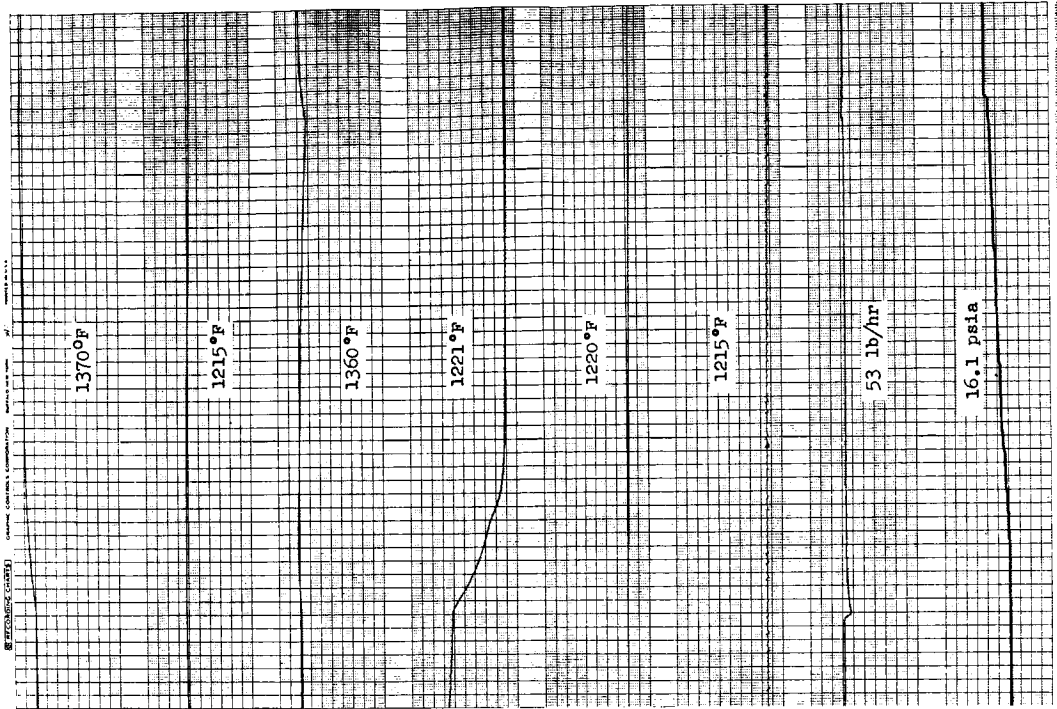
Figure 27. Liquid Vapor Interface Test (50 KW Facility, 5/8-Inch Tube with 1/4-Inch Tubular Insert).
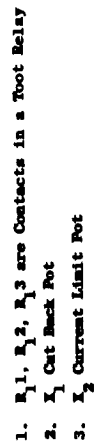
Figure 28. Variable Automatic Power Cut Back Circuit – 100 KW Loop.

1. R_1, R_2, R_3 are Contacts in a Toot Relay
2. X_1 Cut Back Pot
3. X_2 Current Limit Pot
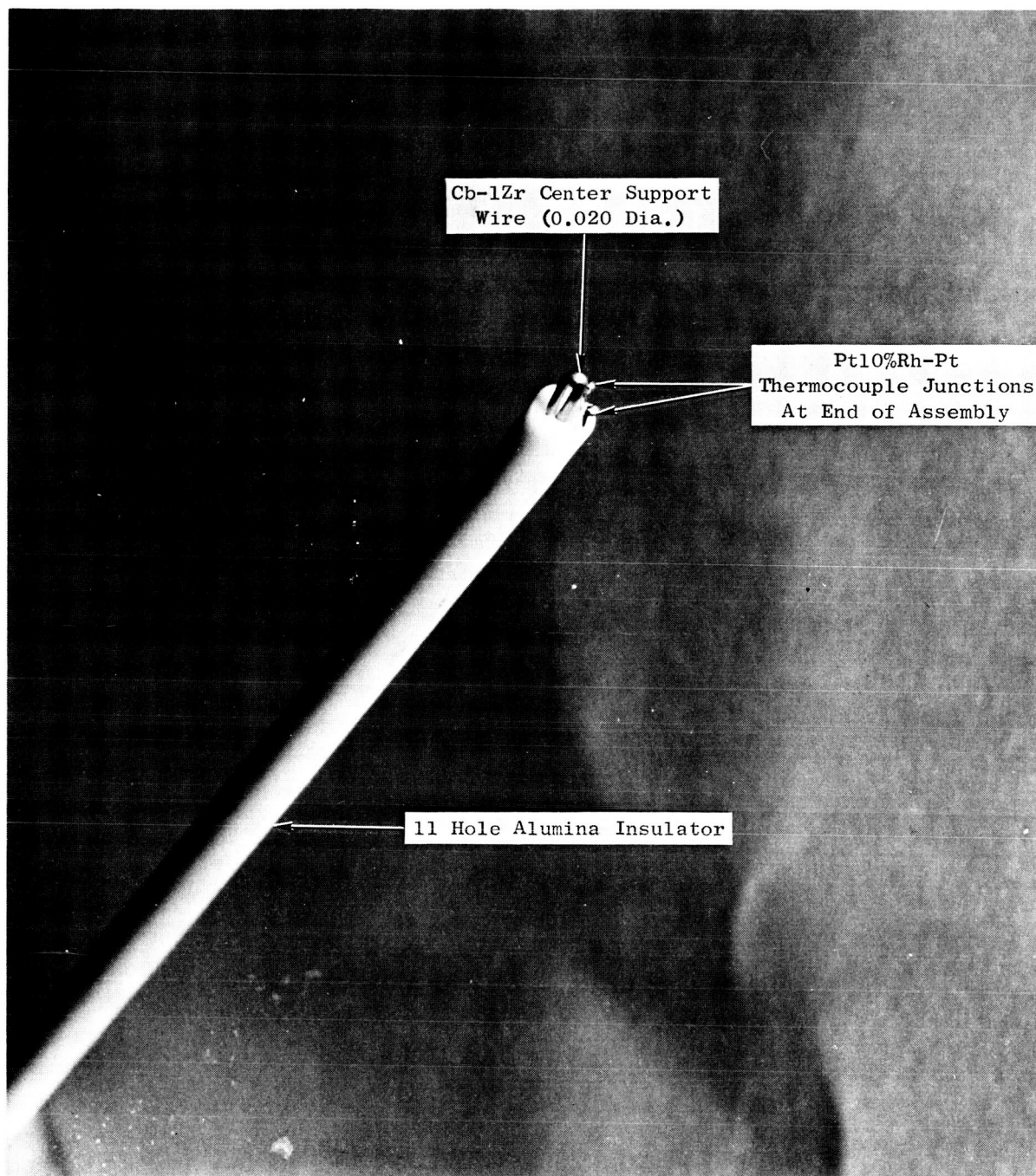
Figure 29. Thermocouple Junction at the End of an 11-Hole Insulator - 100 KW Facility.

Slotted Alumina
Insulator

Pt10%Rh-Pt Thermocouple
Junction at Intermediate
Location (0.010 Inch Dia Wire)

11 Hole Alumina
Insulators
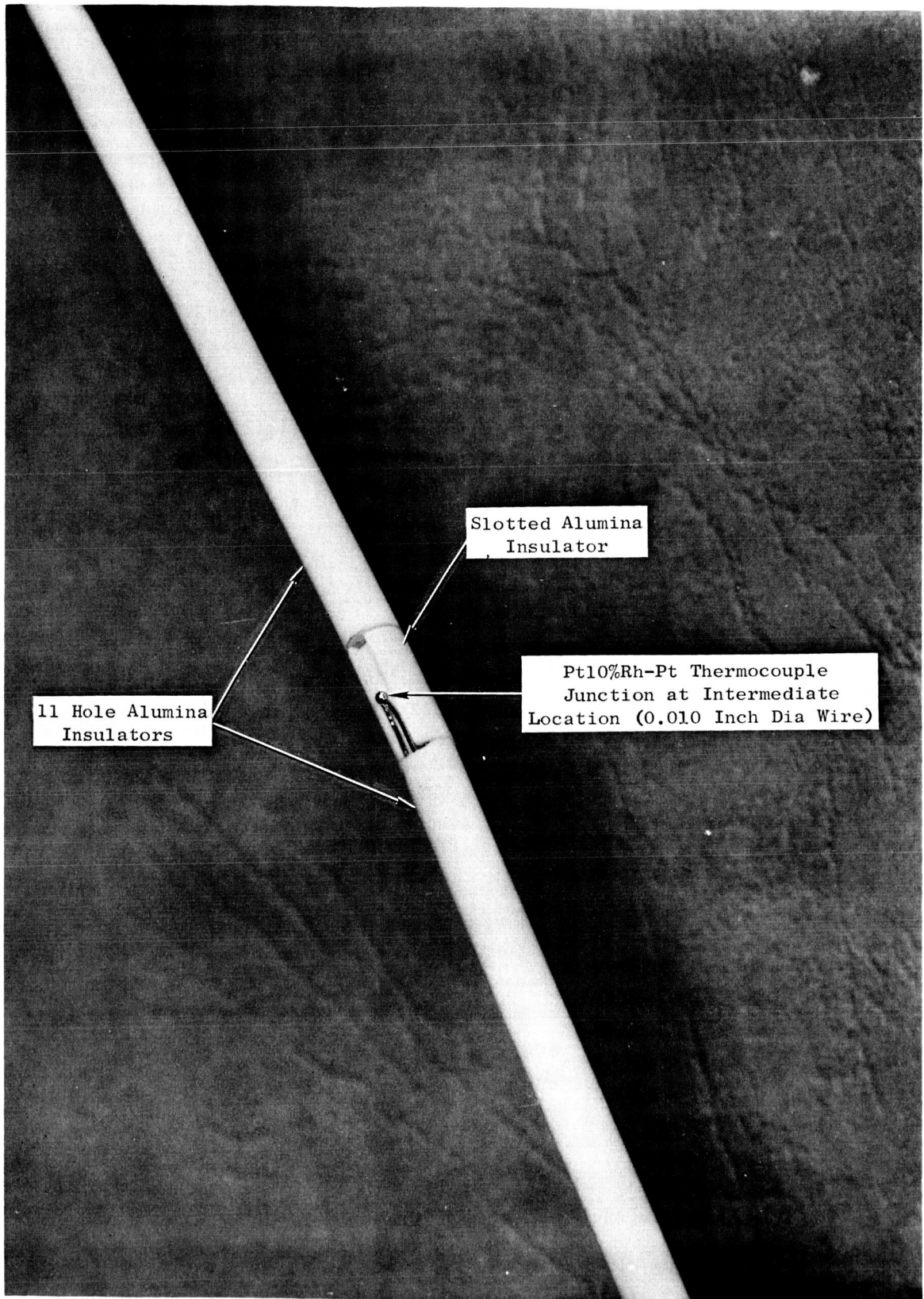
Figure 30.   Thermocouple Junction in Slotted Insulator -
            100 KW Facility.

11 Hole Alumina Insulator 0.125 Inch OD. This Part of Assembly is Installed Inside Insert Tube

Single Hole Alumina Insulators (0.032 Inch OD)

Center Support Wire 0.020 Inch Cb-1Zr

2 Hole Alumina Insulators 0.062 Inch OD With 0.010 Inch Alloy Wires
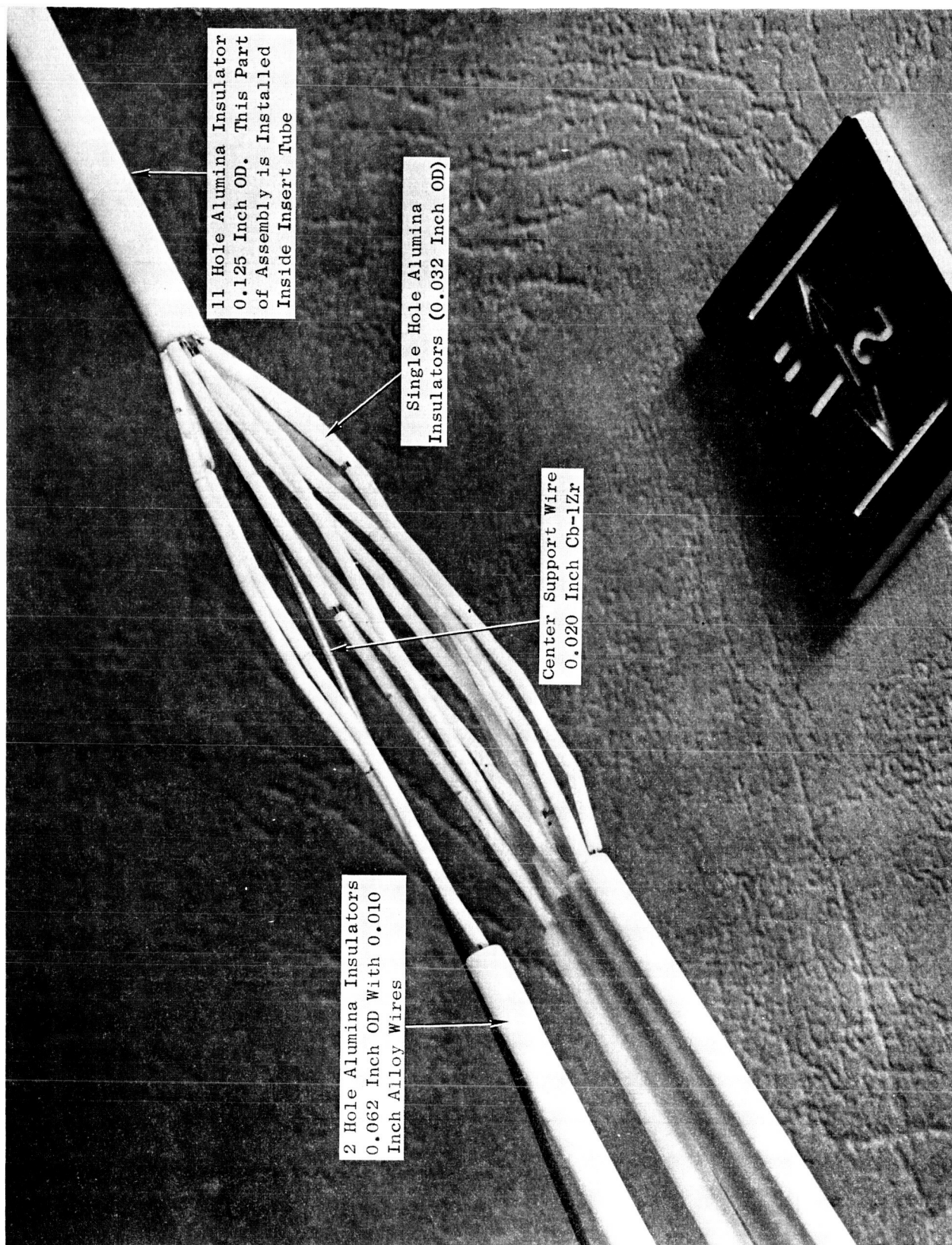
Figure 31.   Transition Between 11-Hole Insulator and 2-Hole Insulator – 100 KW Facility.
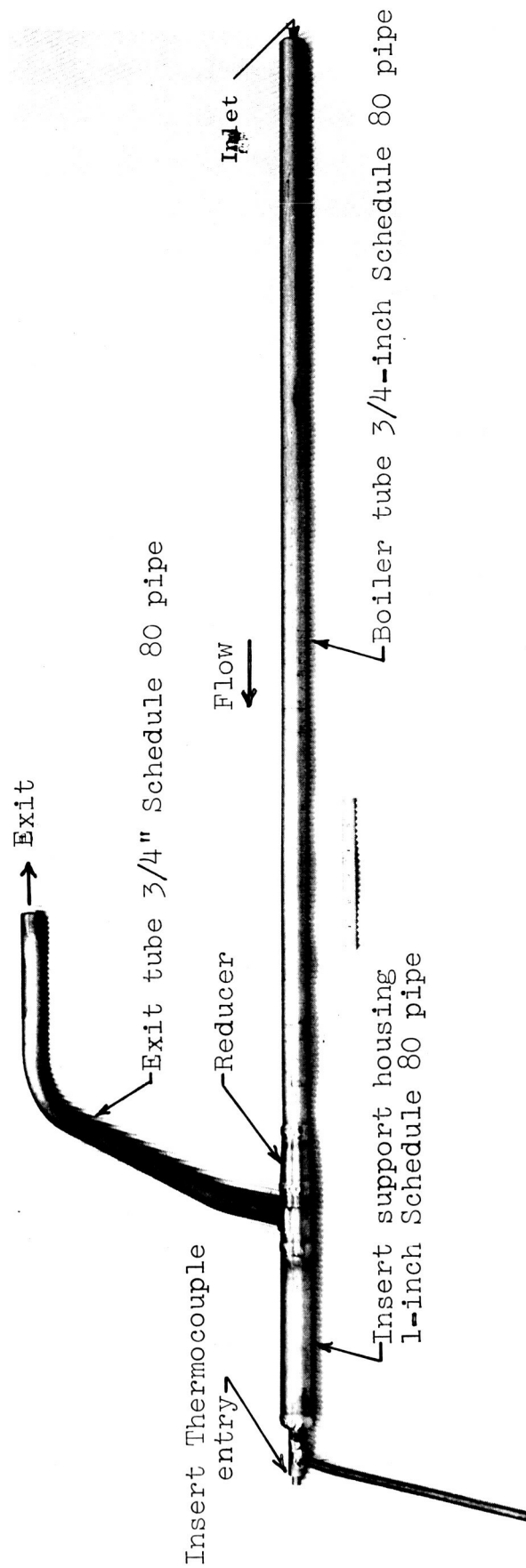
Figure 32. Cb-1Zr Test Section No. 4 for 100 KW Loop With Insert Installed.

Thermocouple entry

Insert support
3/8-inch Schedule 80 pipe

Vent tube

Helical swirl

Flow

Inlet plug
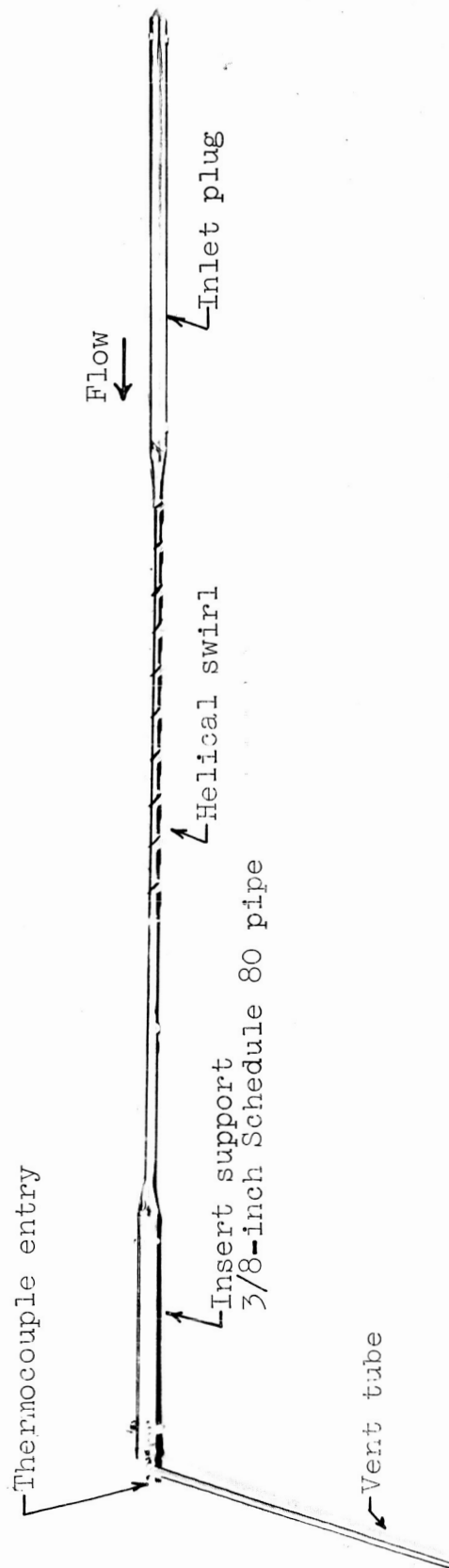
Figure 33. Cb-1Zr Helical-Plug Insert for Test Section No. 4, 100 KW Loop.
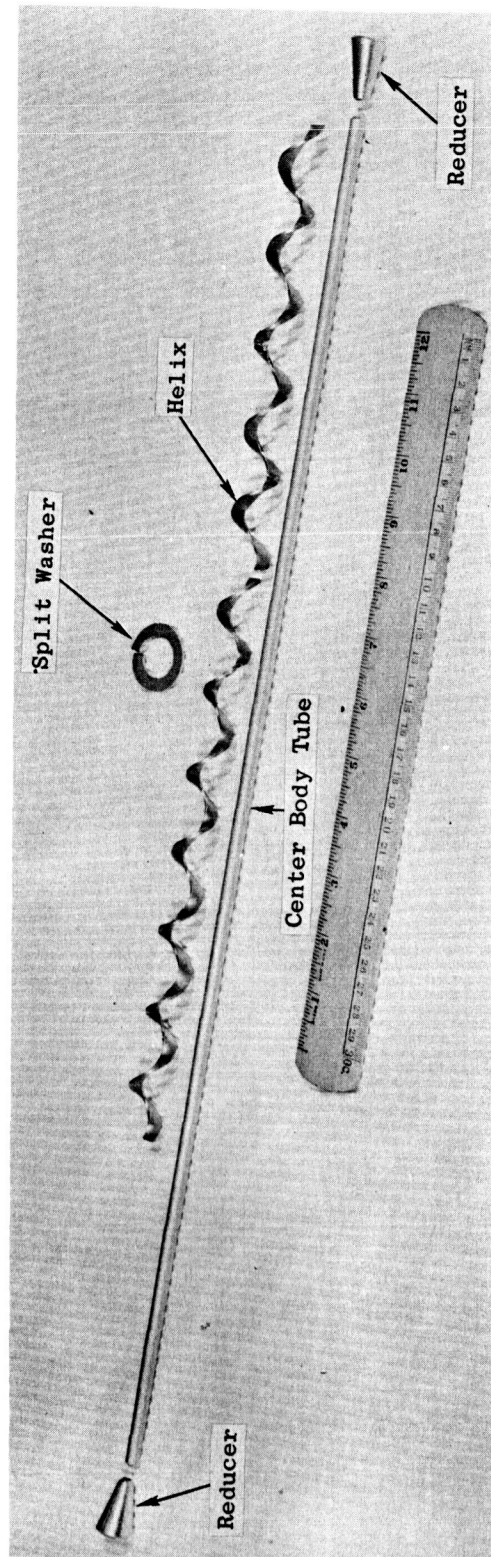
Figure 34. Component Parts of Helix (Test Section No. 4,
100 KW Facility).
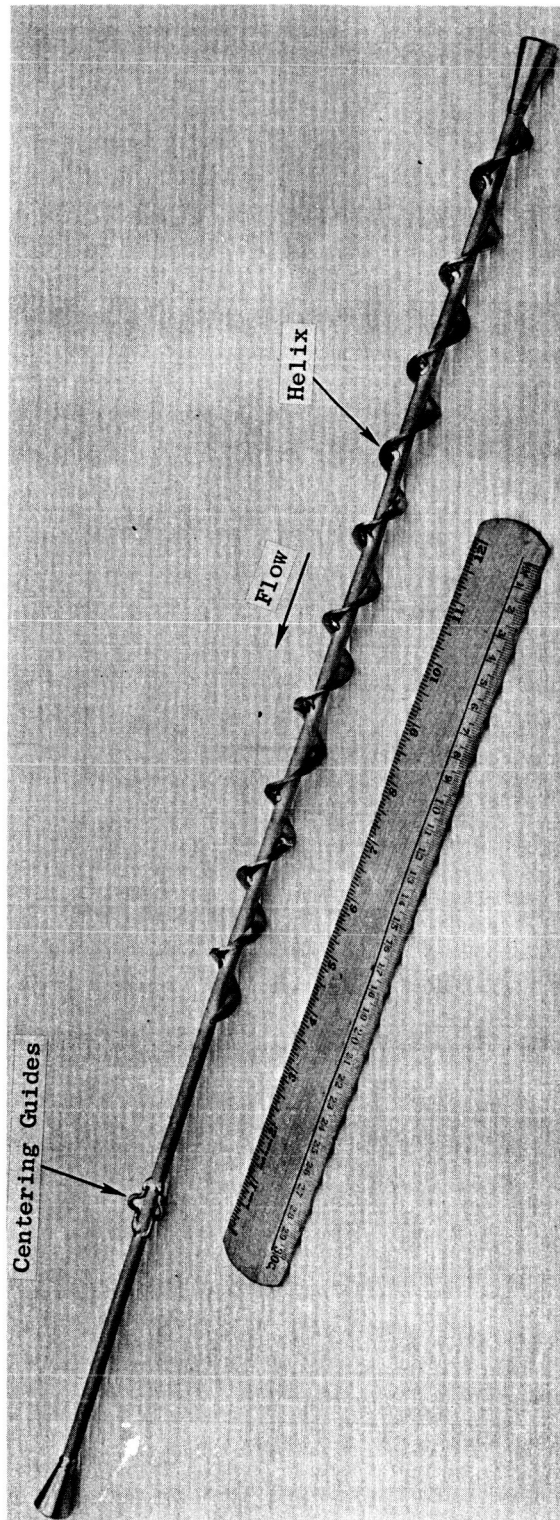
Figure 35. Helix Section of Insert (Test Section No. 4, 100 KW Facility).
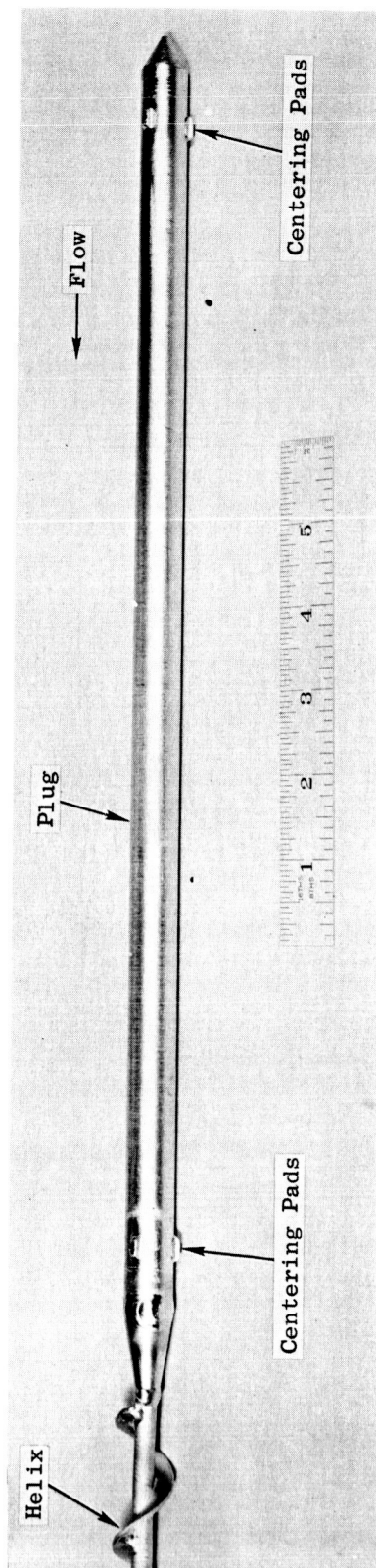
Figure 36. Insert Plug (Test Section No. 4, 100 KW Facility).
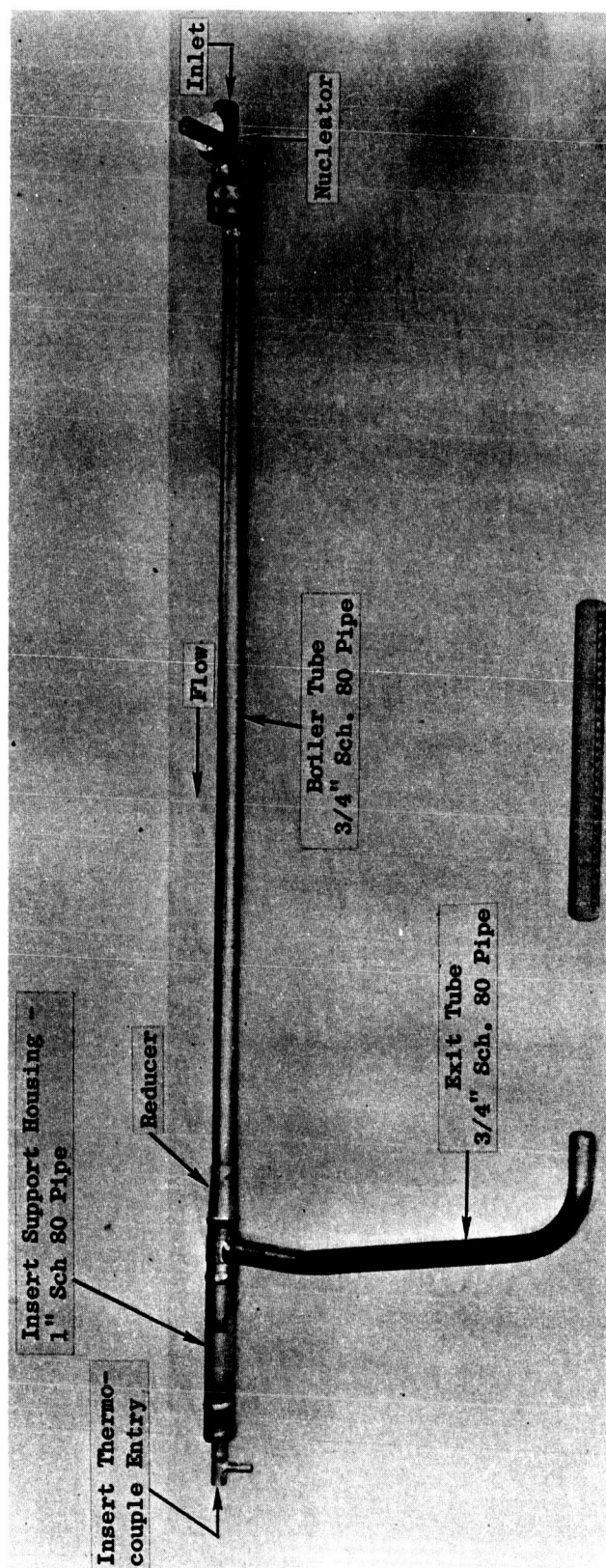
Figure 37. 100.KW Facility Test Section No. 5.
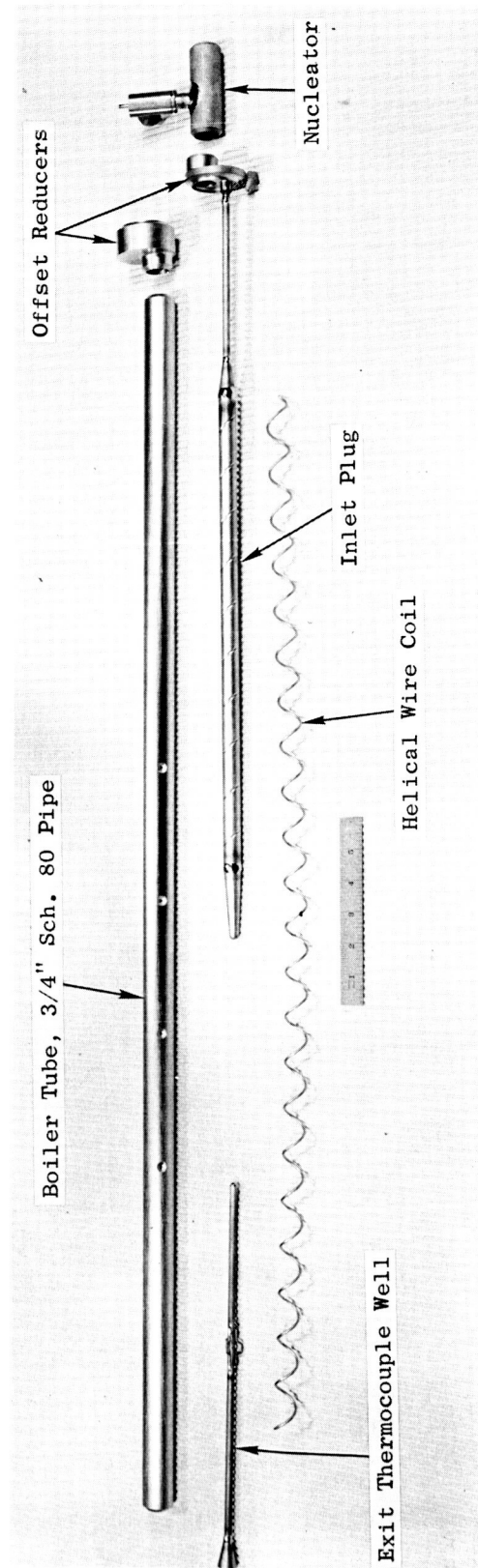
Figure 38. Test Section No. 5 Components, 100 KW Facility.
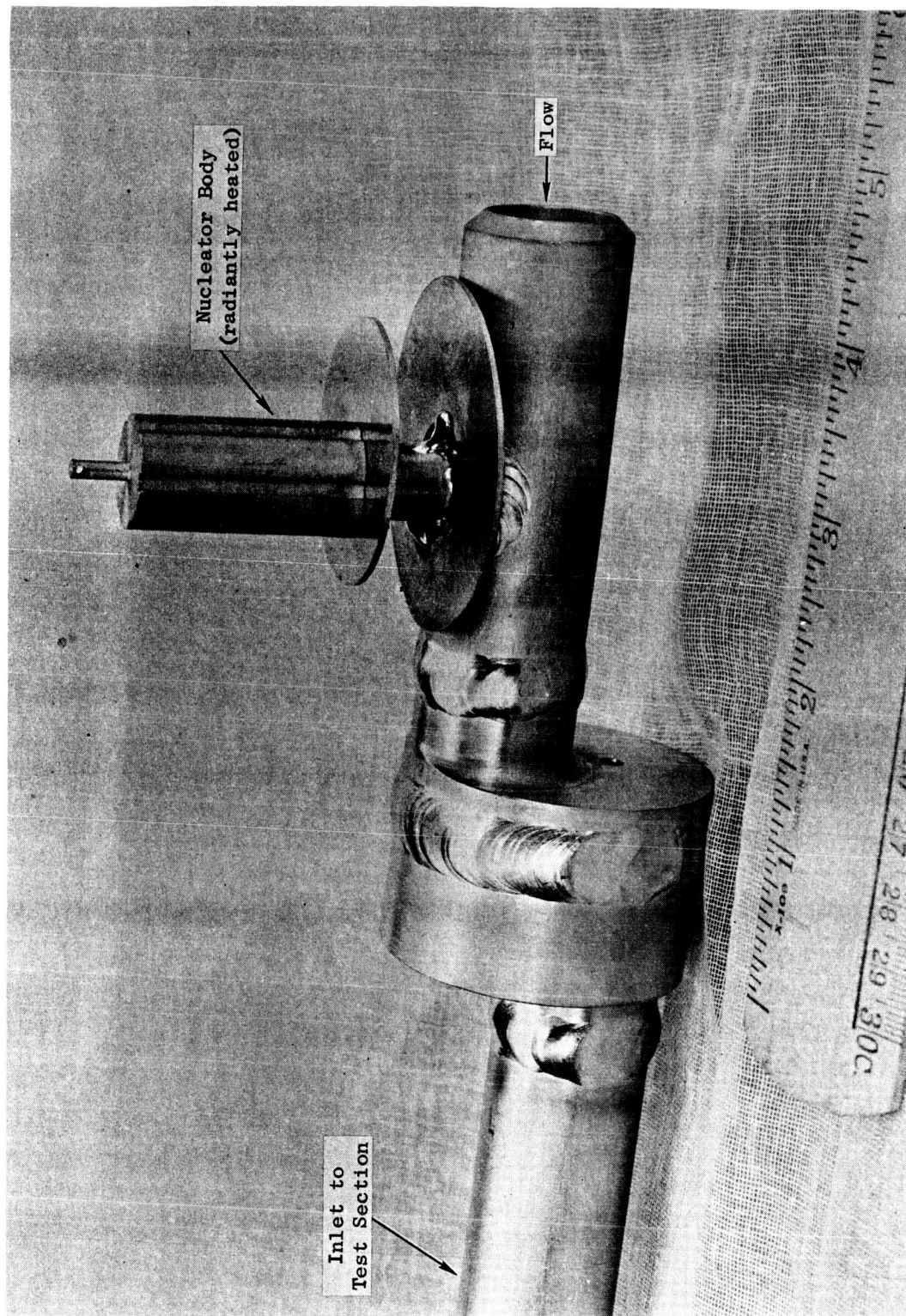
Figure 39. Boiling Nucleator (Test Section No. 5, 100 KW Facility).
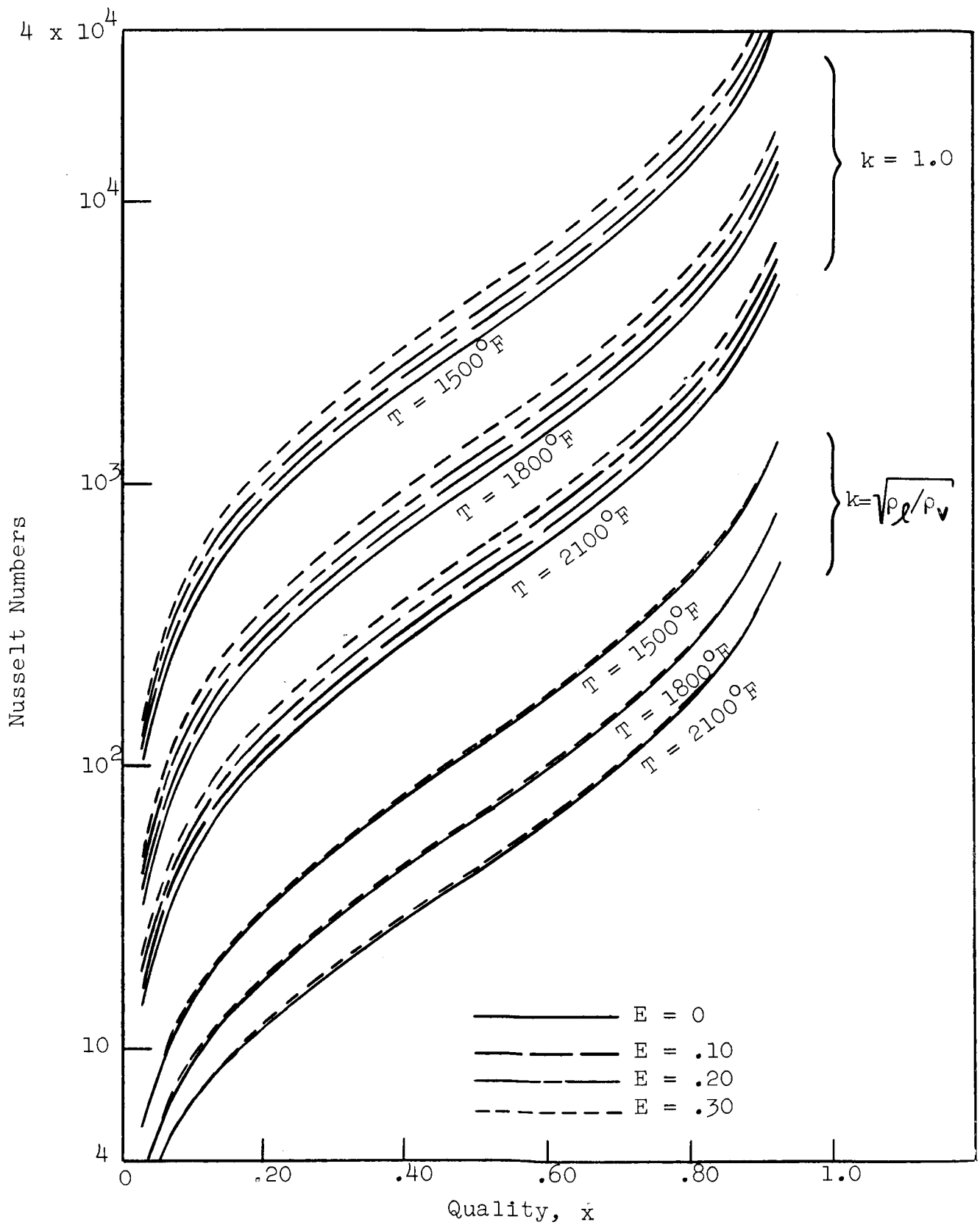
Figure 40. Effect of Liquid Entrainment on the Nusselt Numbers
Calculated from the Film Evaporation Model
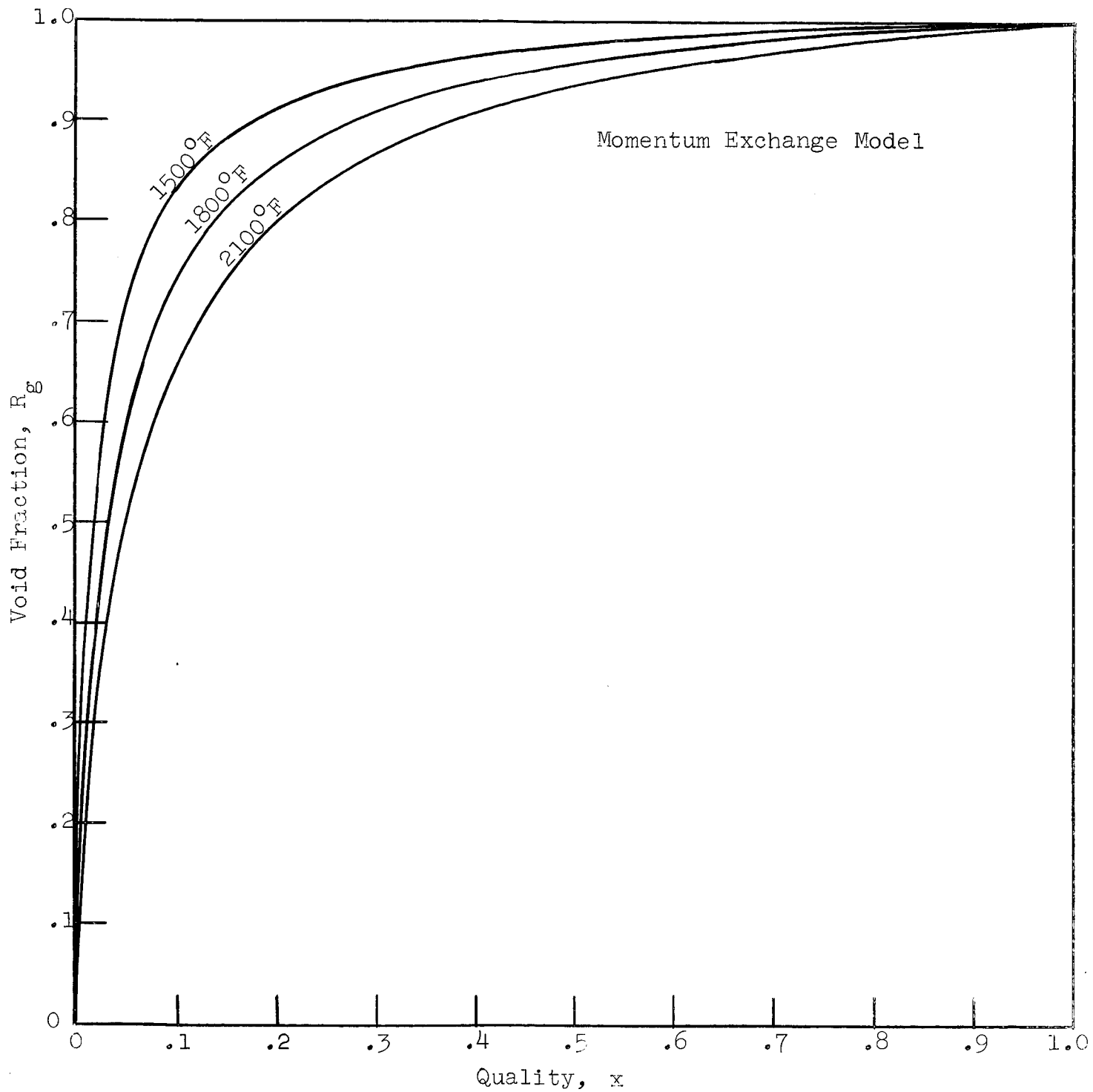
Figure 41. Void Fraction as a Function of Quality for Potassium
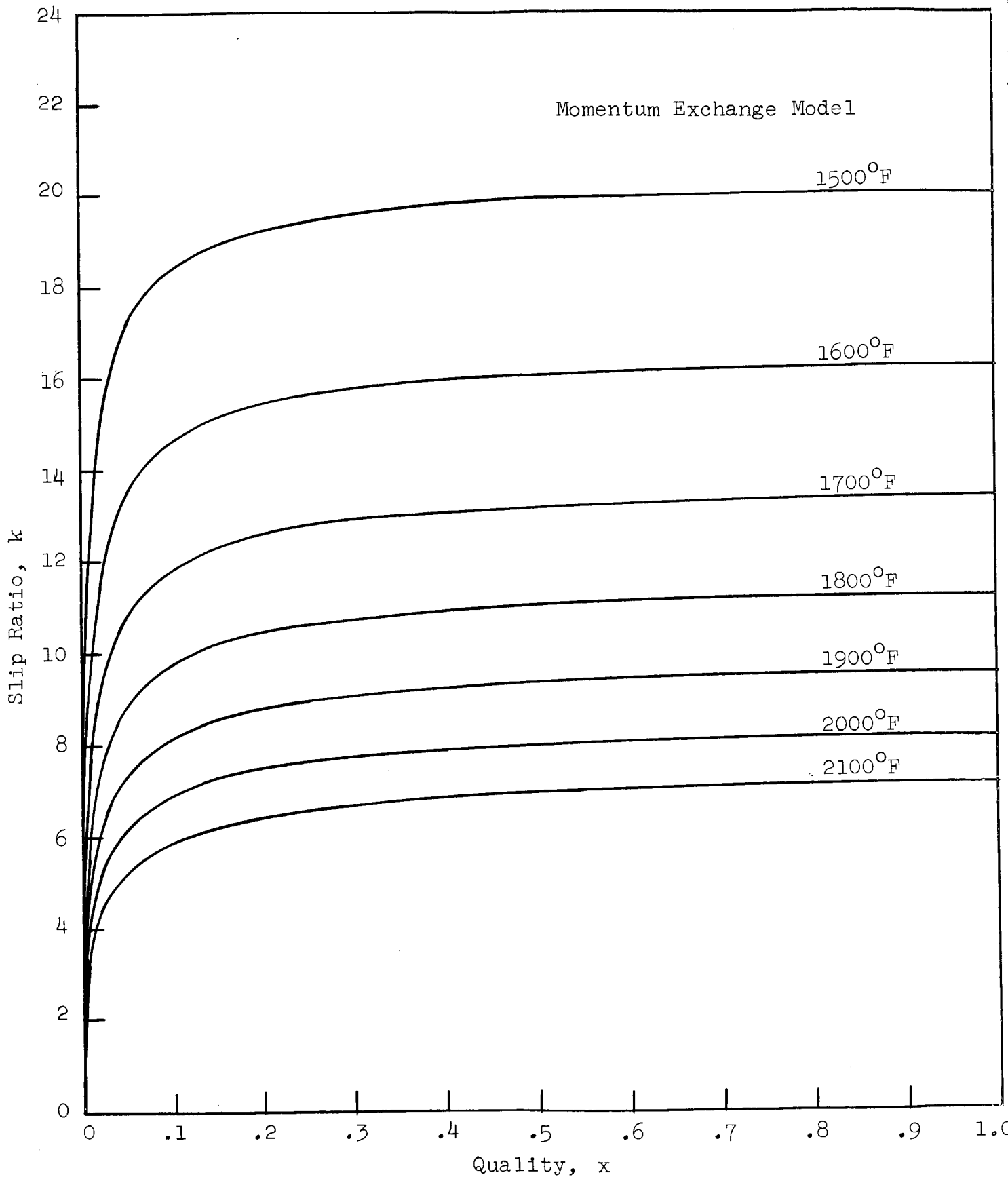
Figure 42.   Slip Ratio as a Function of Quality for Potassium
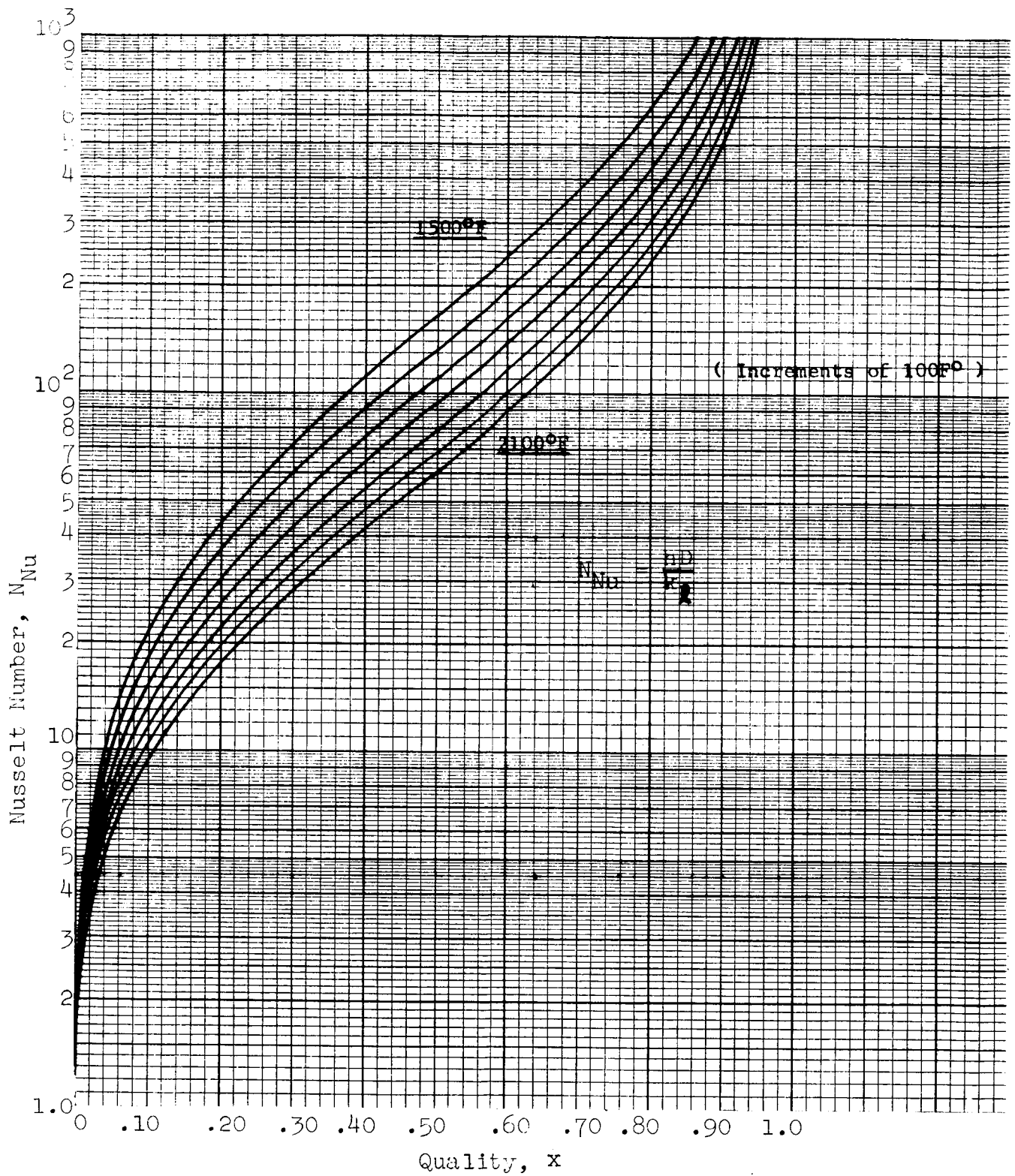
Figure 43. Nusselt Numbers from the Film Evaporation Model

-157-
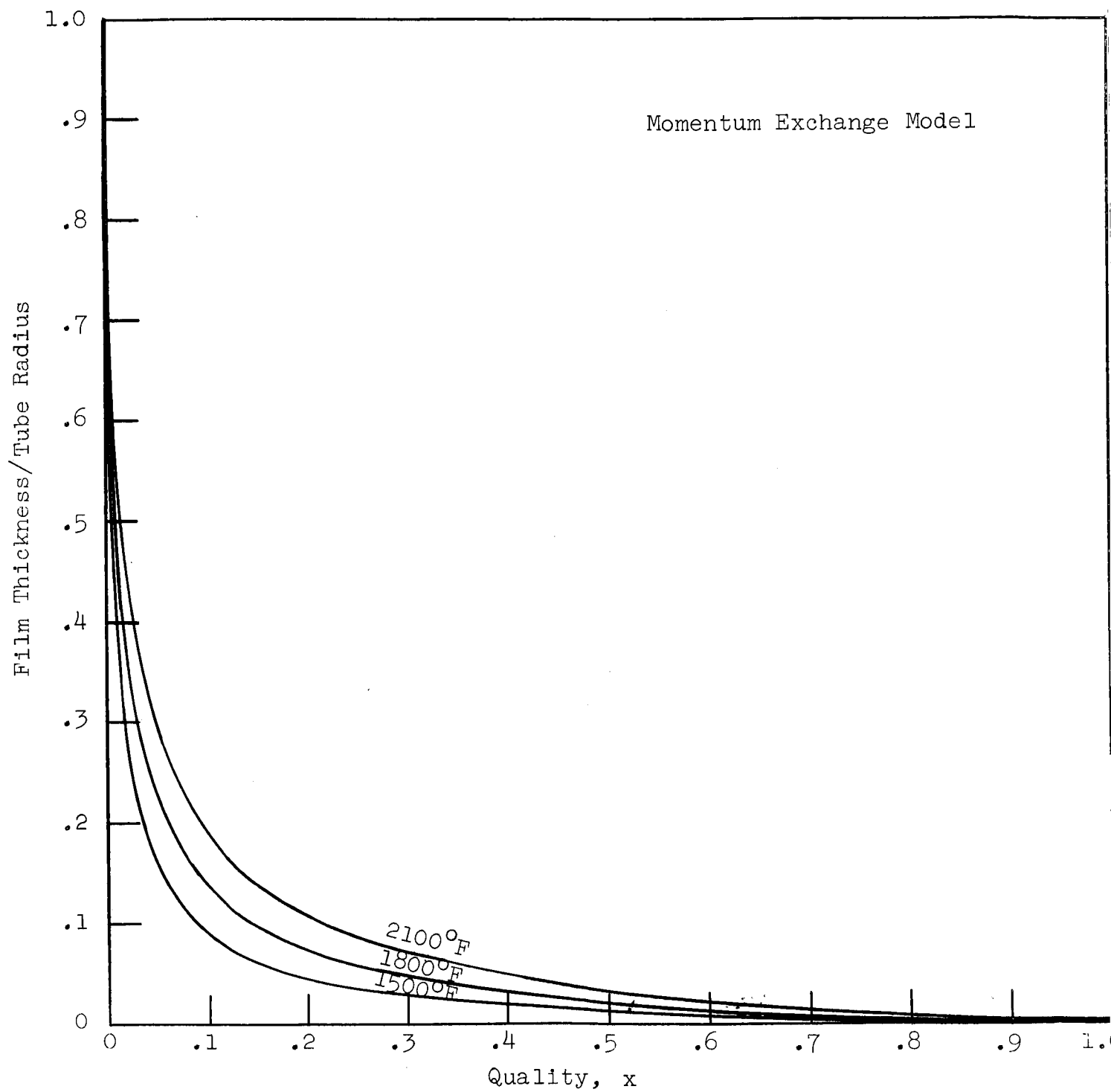
Figure 44.   Film Thickness to Tube Radius Ratio as a Function
of Quality
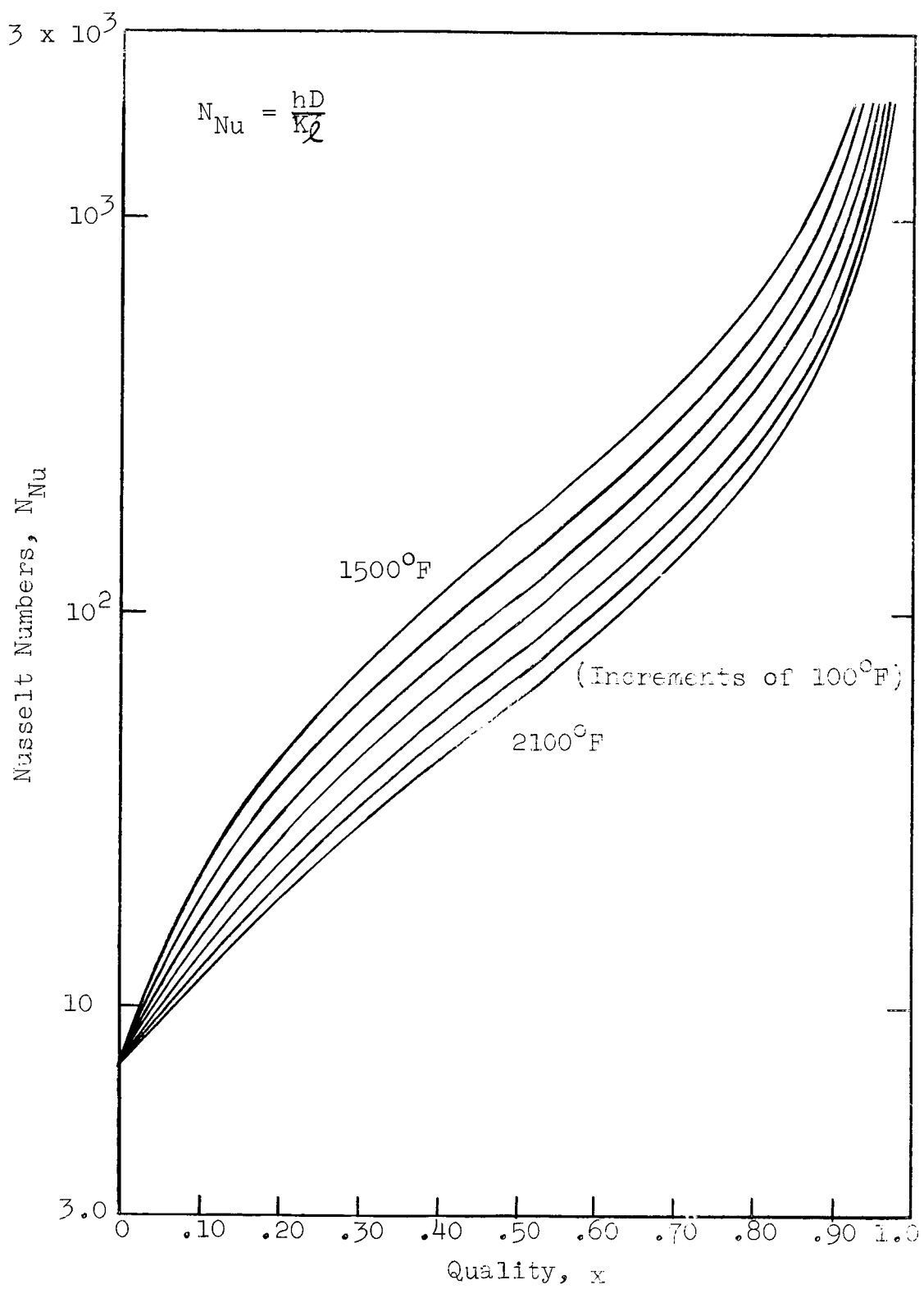
Figure 45. Modified Film Evaporation Nusselt Numbers
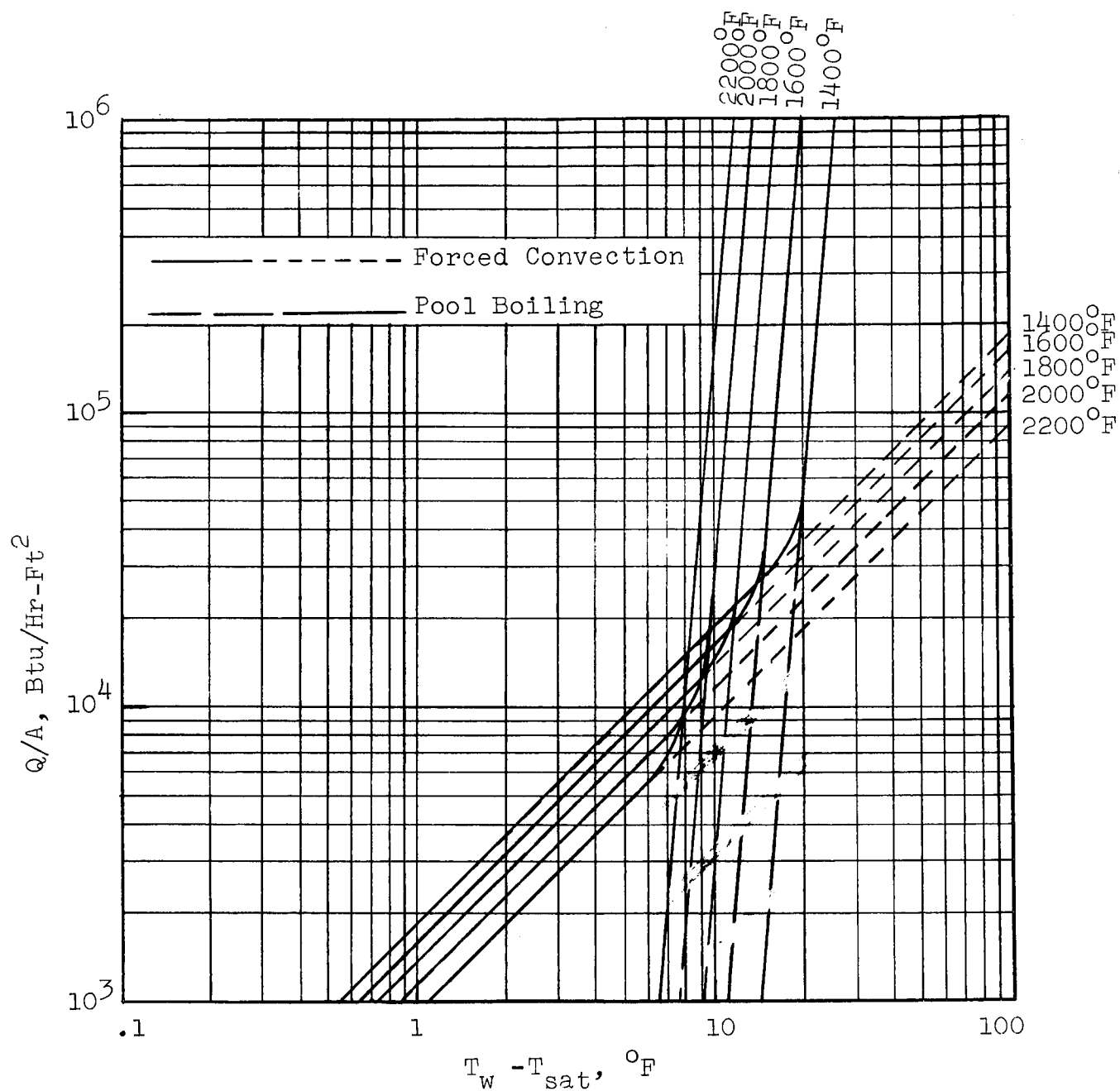
Figure 46. Heat Flux as a Function of $T_w - T_{sat}$ for the Forced Convection Nucleate Boiling Model (Tube I.D. = .767 in.)
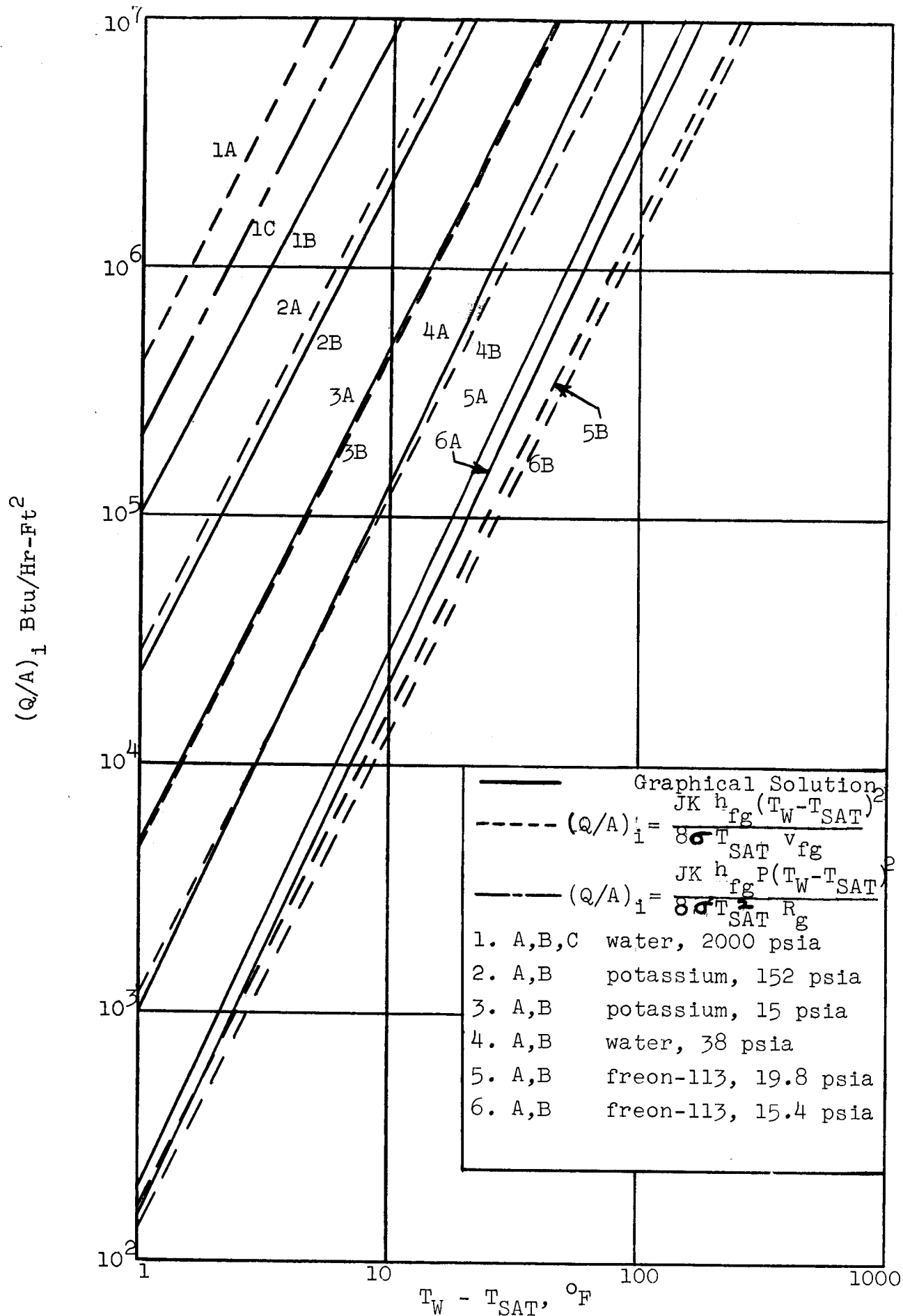
Figure 47.   Superheat Requirements for Incipient
Boiling Several Fluids
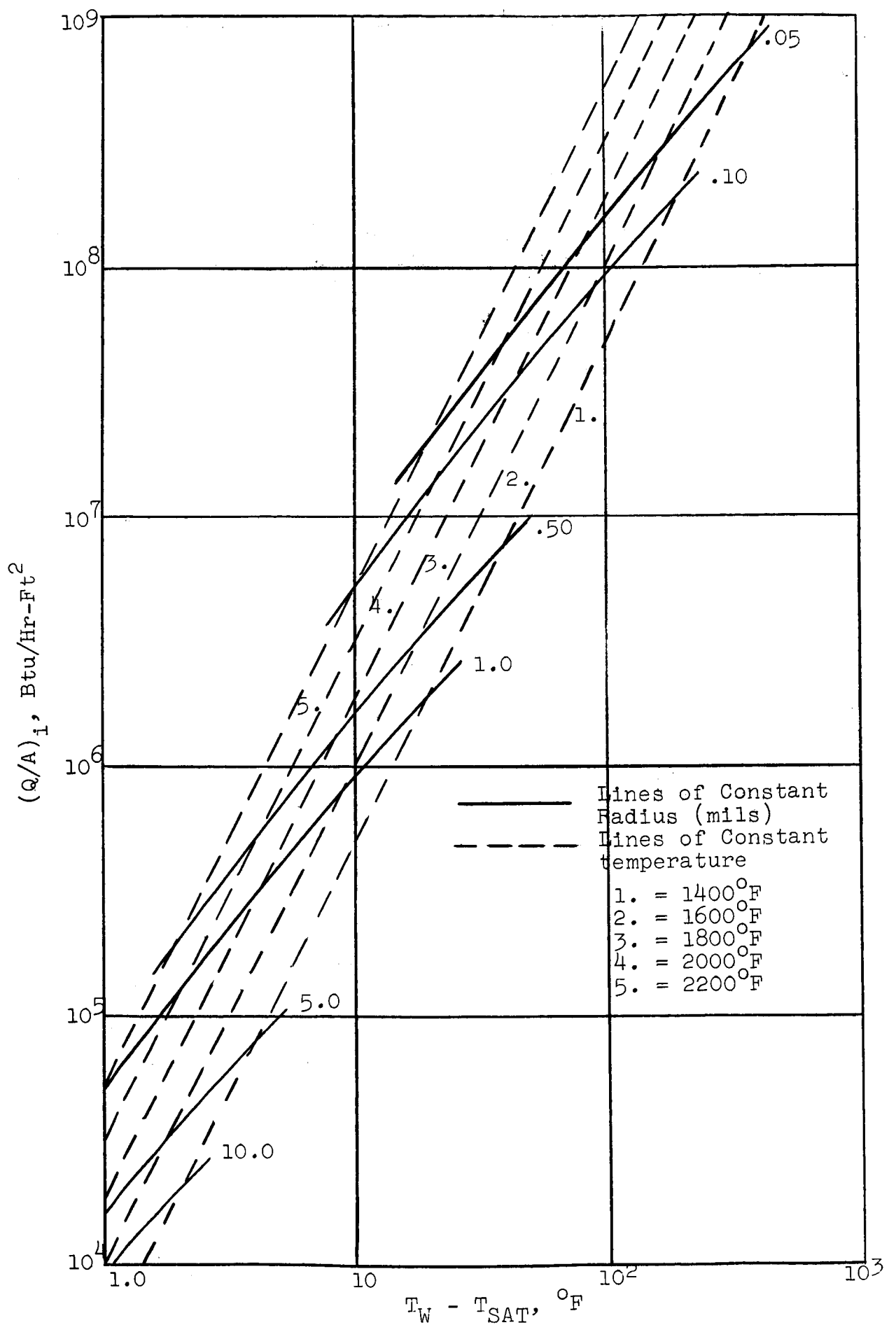
Figure 48.   Superheat Requirements for Incipient Boiling of Potassium

-162-
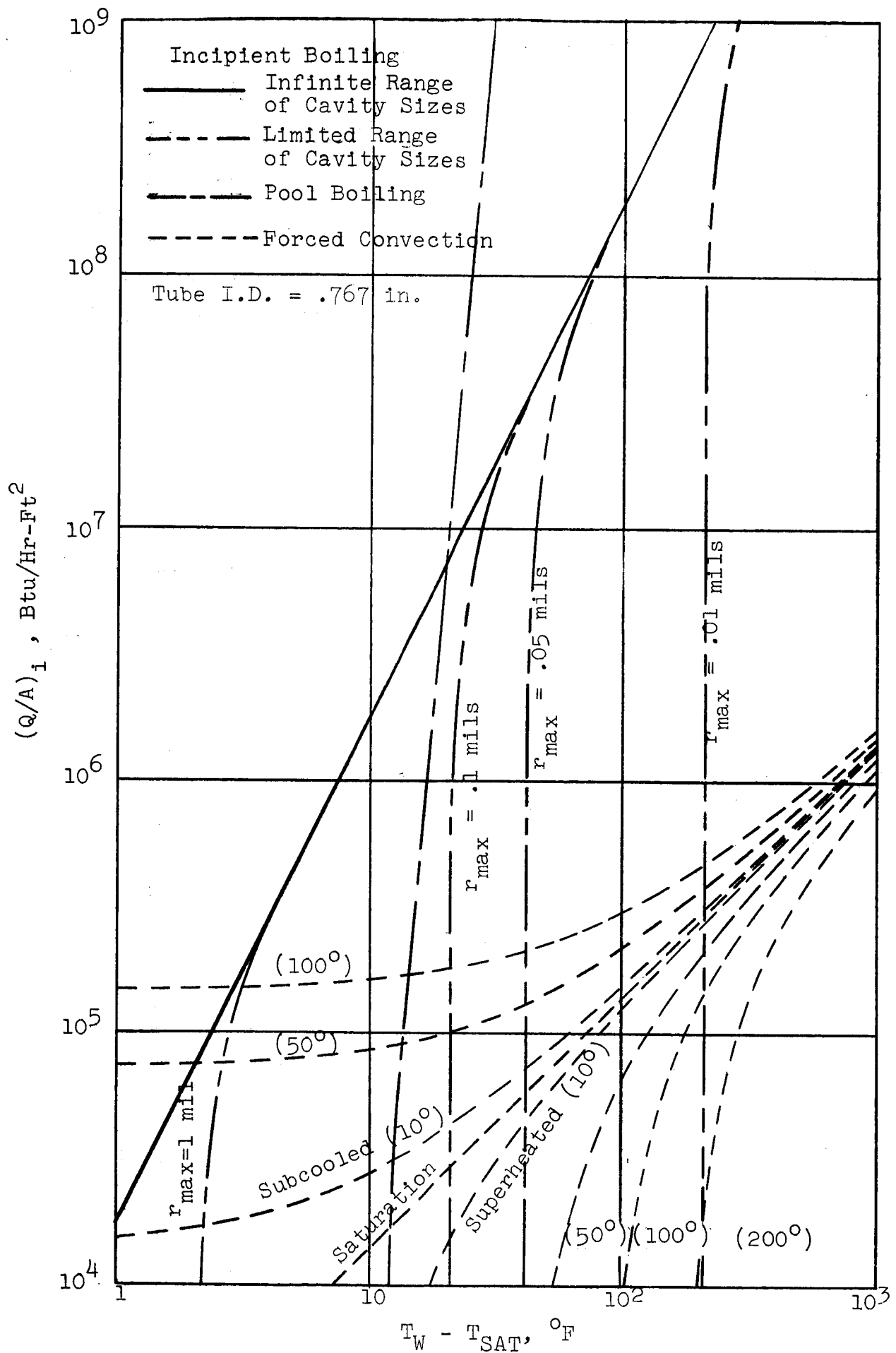
Figure 49. Effect of Cavity Size on Superheat
Requirements for Incipient Boiling
of Potassium (T_{sat} = 1800°F)
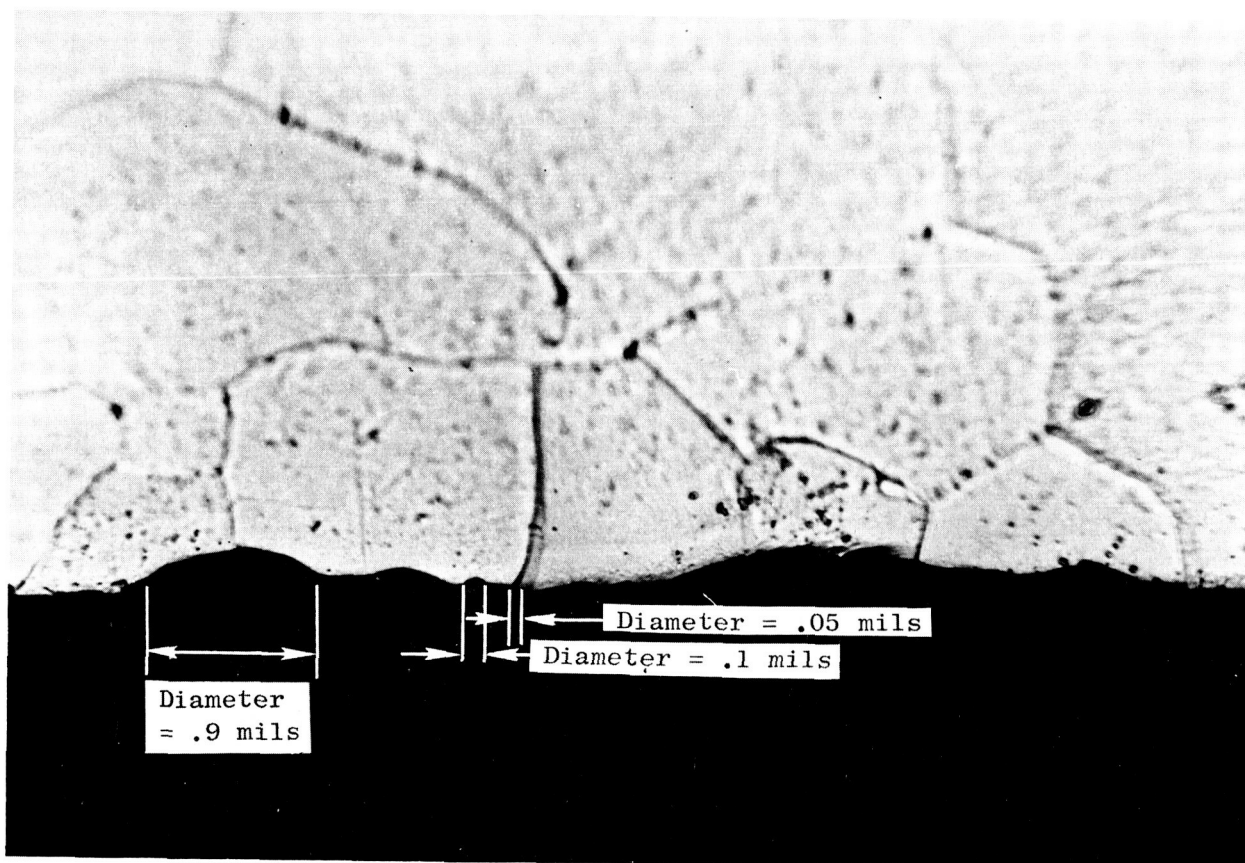
Figure 50a. Micrograph of 100 KW Boiling Surface (ID Transverse
Magnified 1000 X - Polished But Not Etched) 3/4-Inch
Sch. 80 Cb-1Zr Pipe (MCN-1209-1).
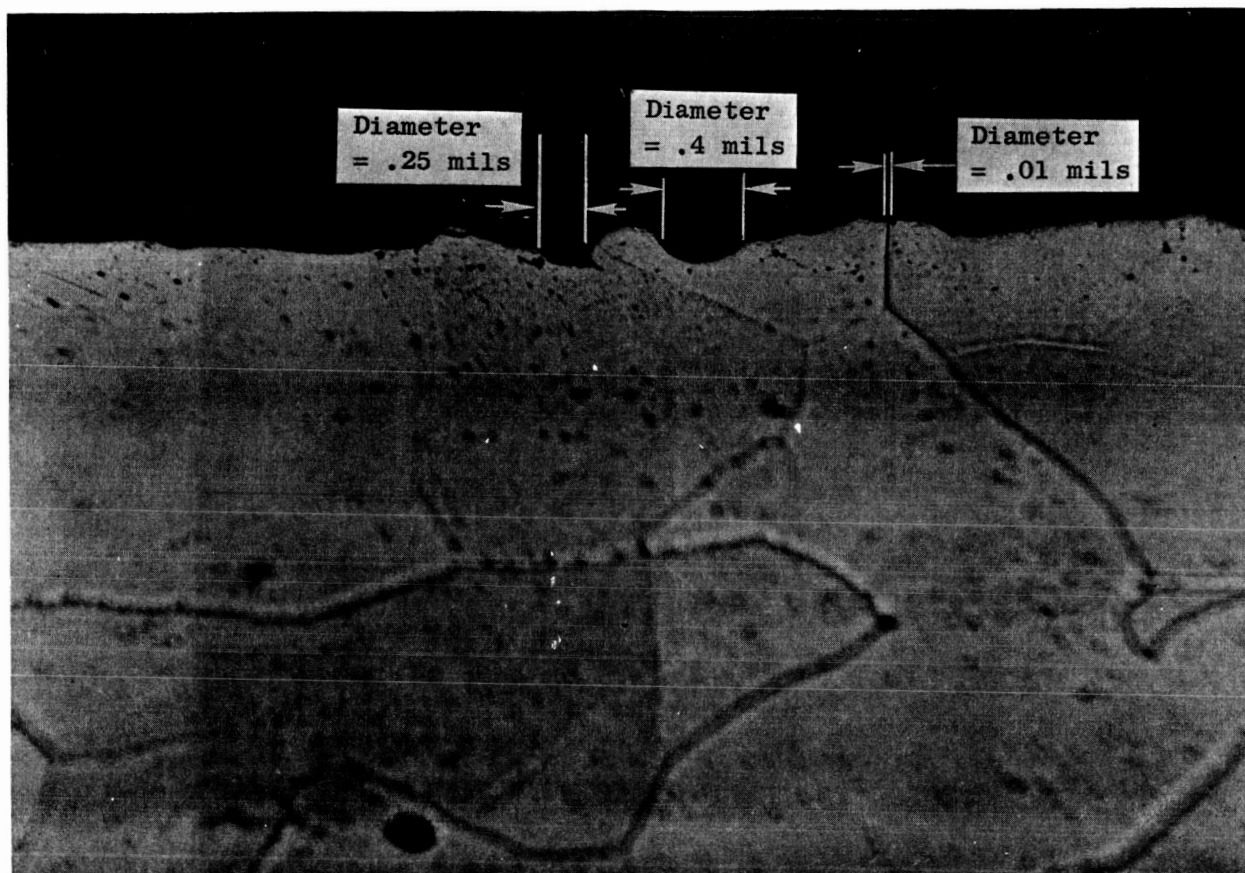
Figure 50b. Micrograph of 100 KW Boiling Surface (ID Longitudinal
Magnified 1000 X - Polished But Not Etched) 3/4-Inch
Sch. 80 Cb-1Zr Pipe (MCN-1209-1).
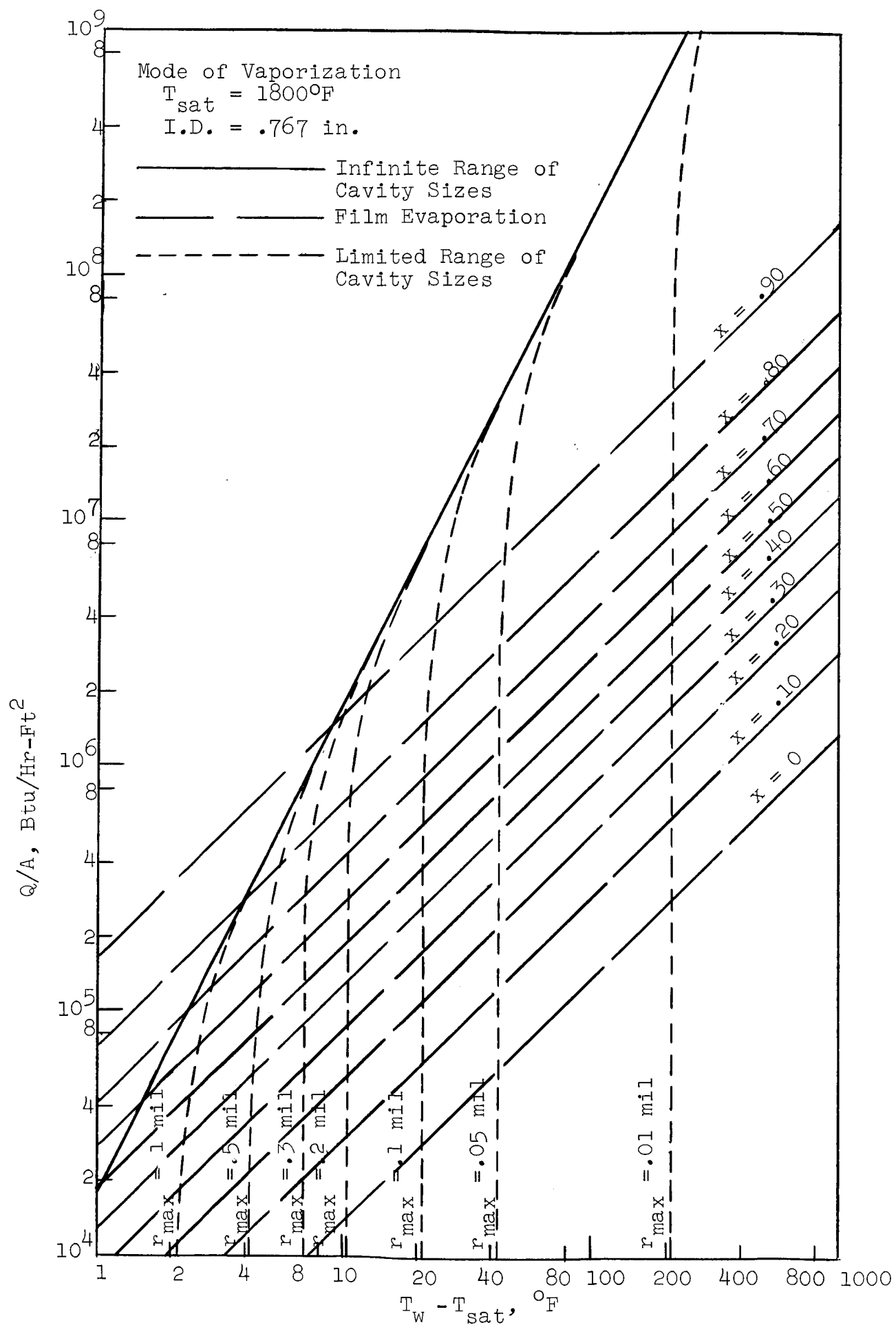
Figure 51. Quality Requirements for Boiling Suppression
(T_{sat} = 1800°F)
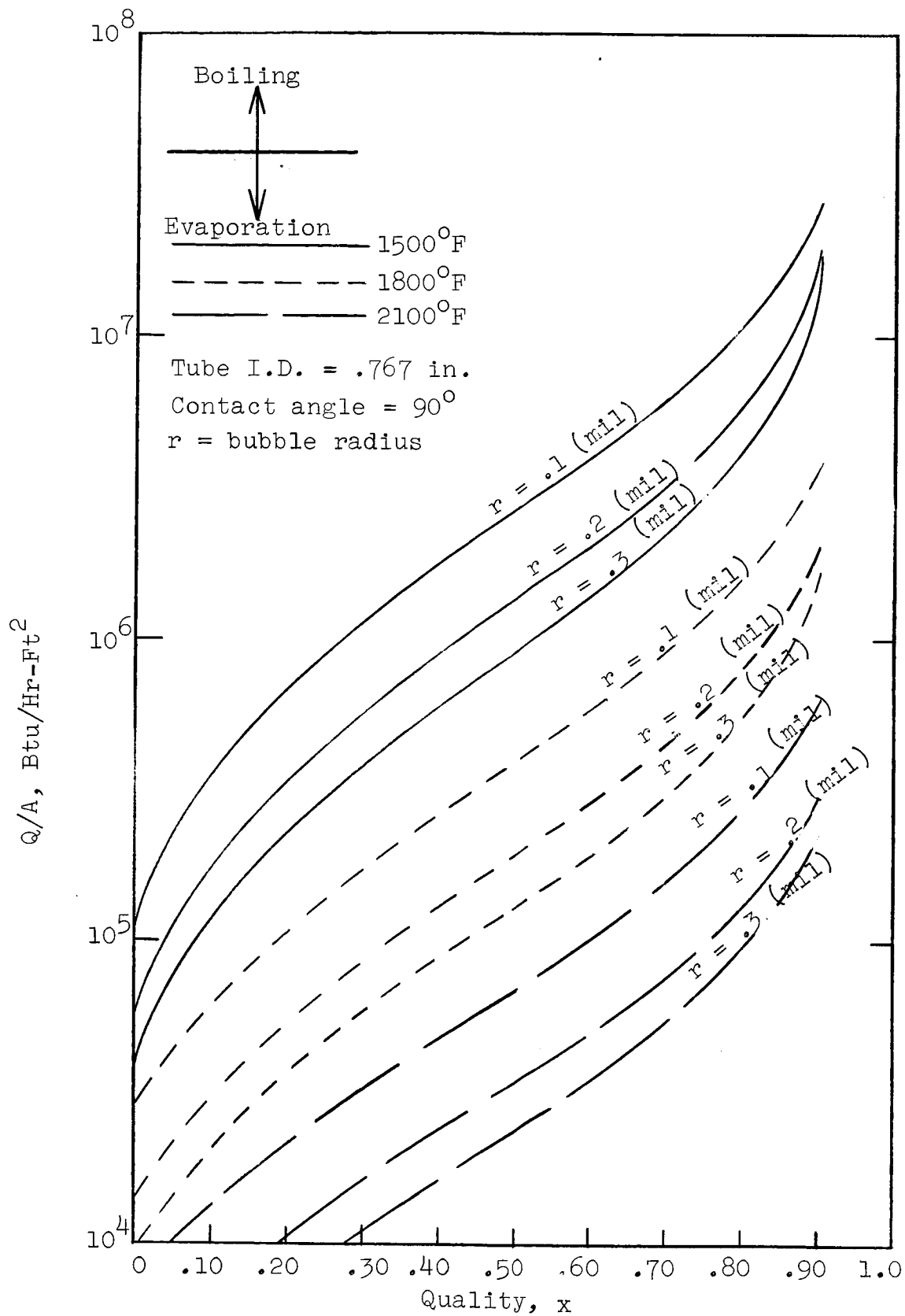
Figure 52a. Vaporization Regimes of Potassium (Heat Fluxes
Less Than the Critical)
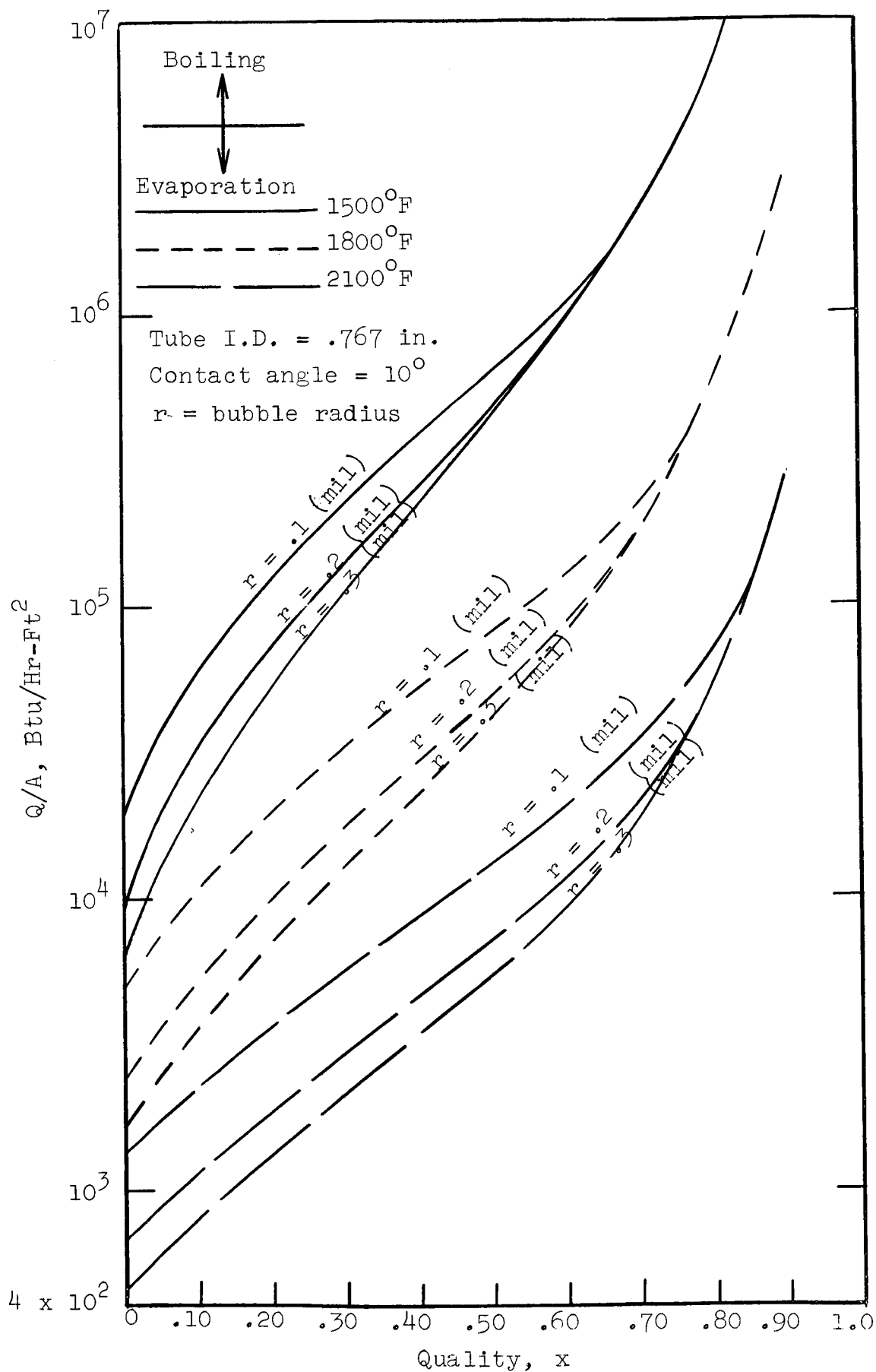
Figure 52b. Vaporization Regimes of Potassium (Heat Fluxes Less Than the Critical)

-168-
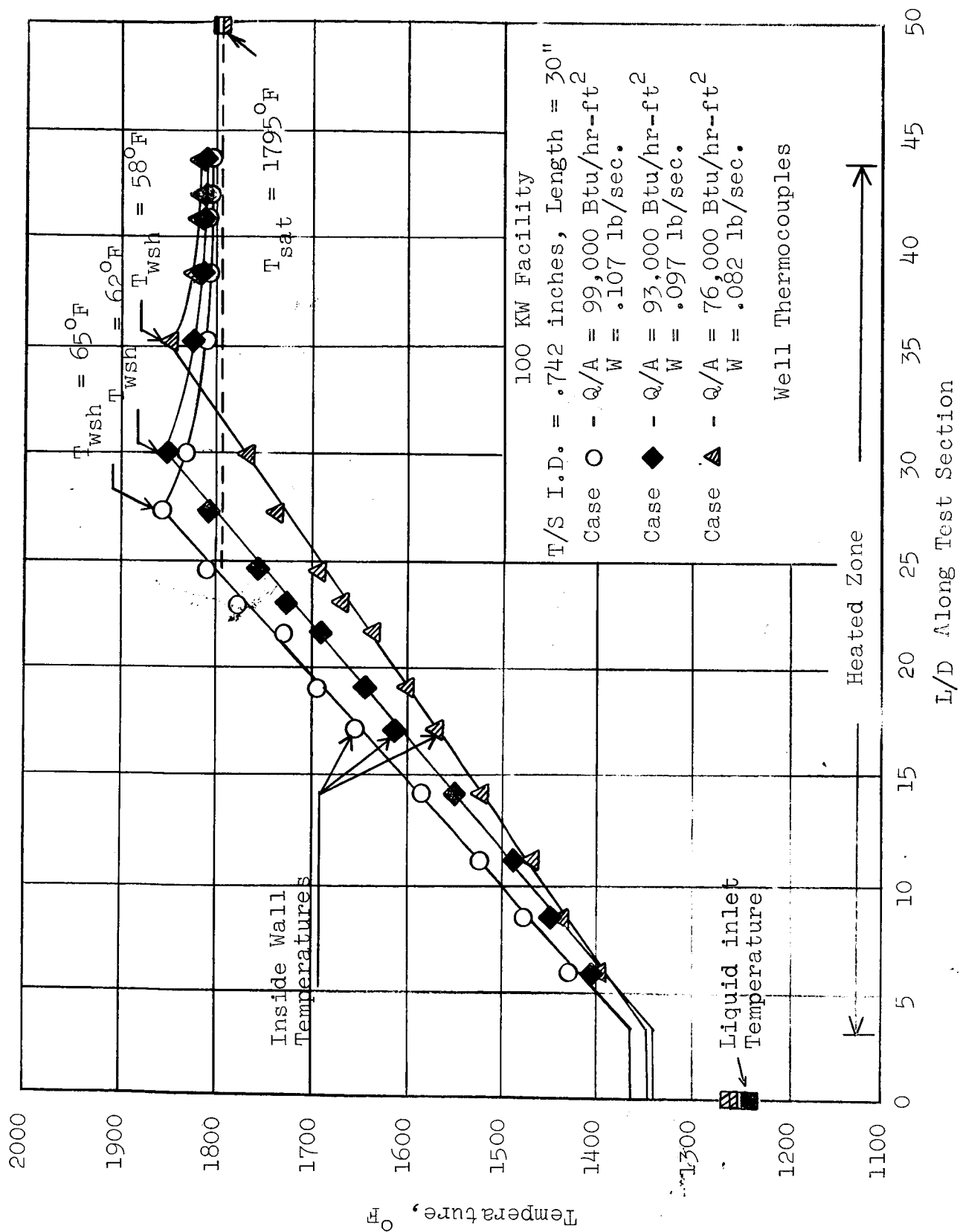
Figure 53a. Inside Wall Temperature as a Function of L/D (100 KW Test Section)
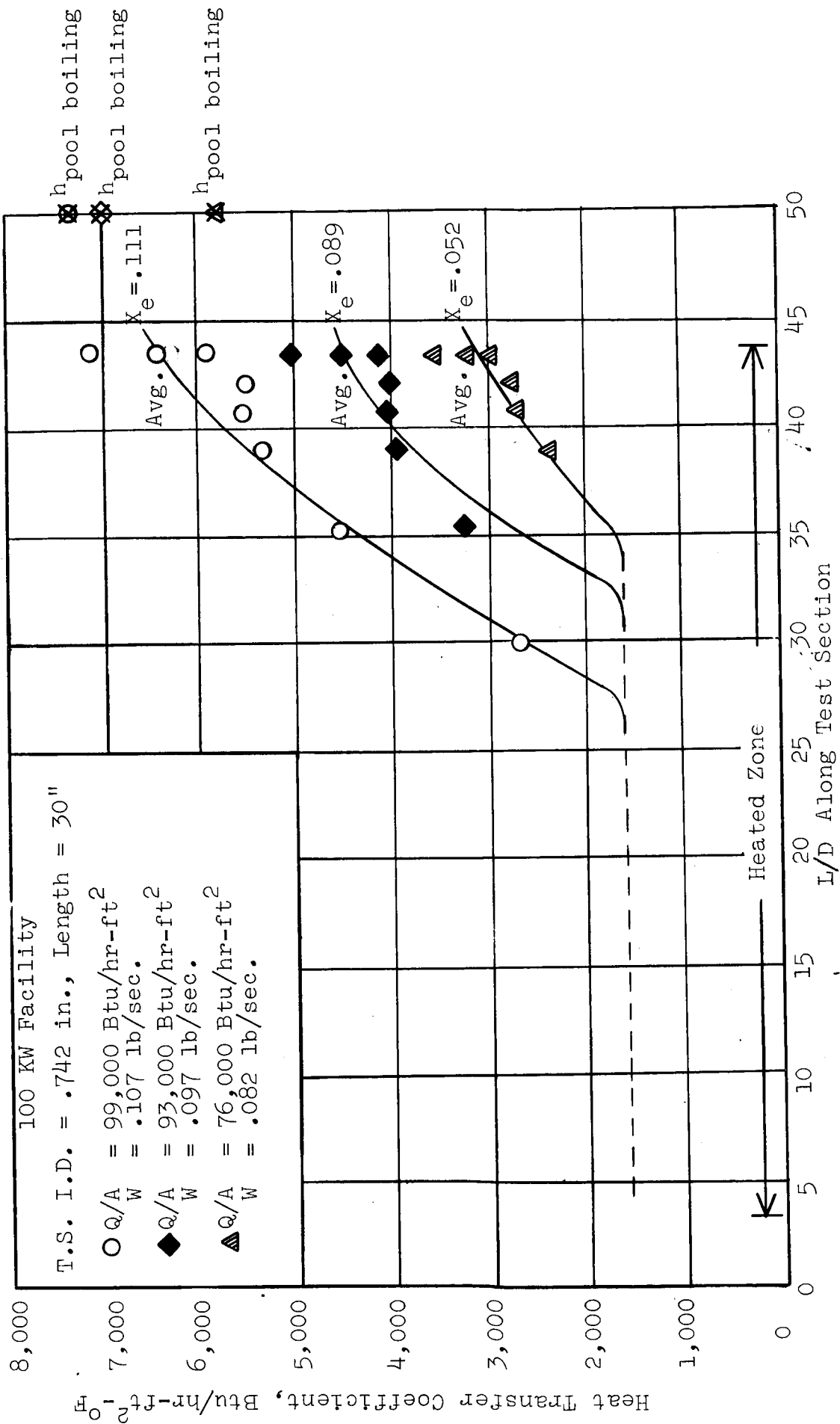
Figure 53b. Heat Transfer Coefficient as a Function of L/D (100 KW Test Section)
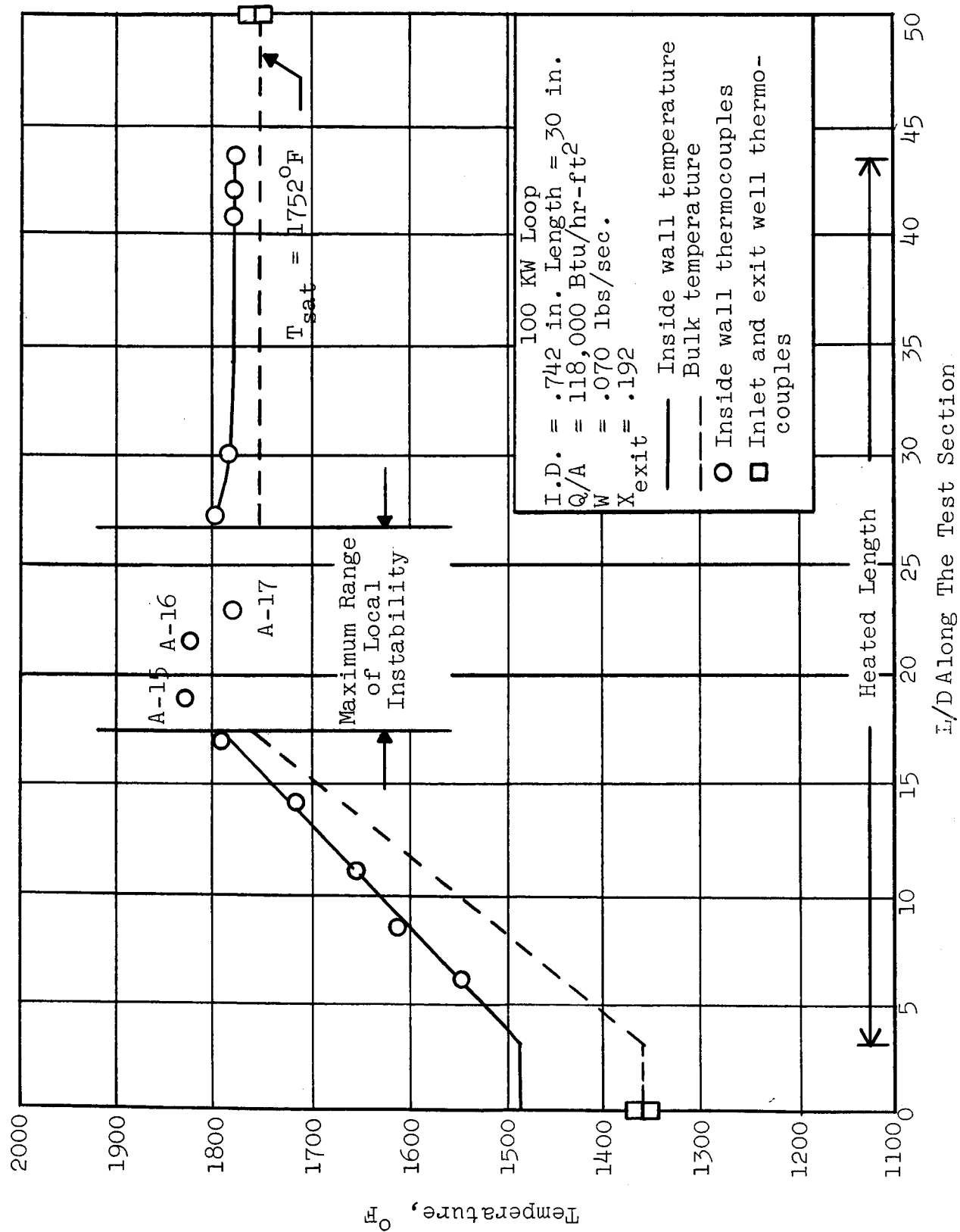
Figure 54. Inside Wall Temperature as a Function of L/D (100 KW Test Section) (Plot Shows the Local Instability Associated with the Boiling Boundary)
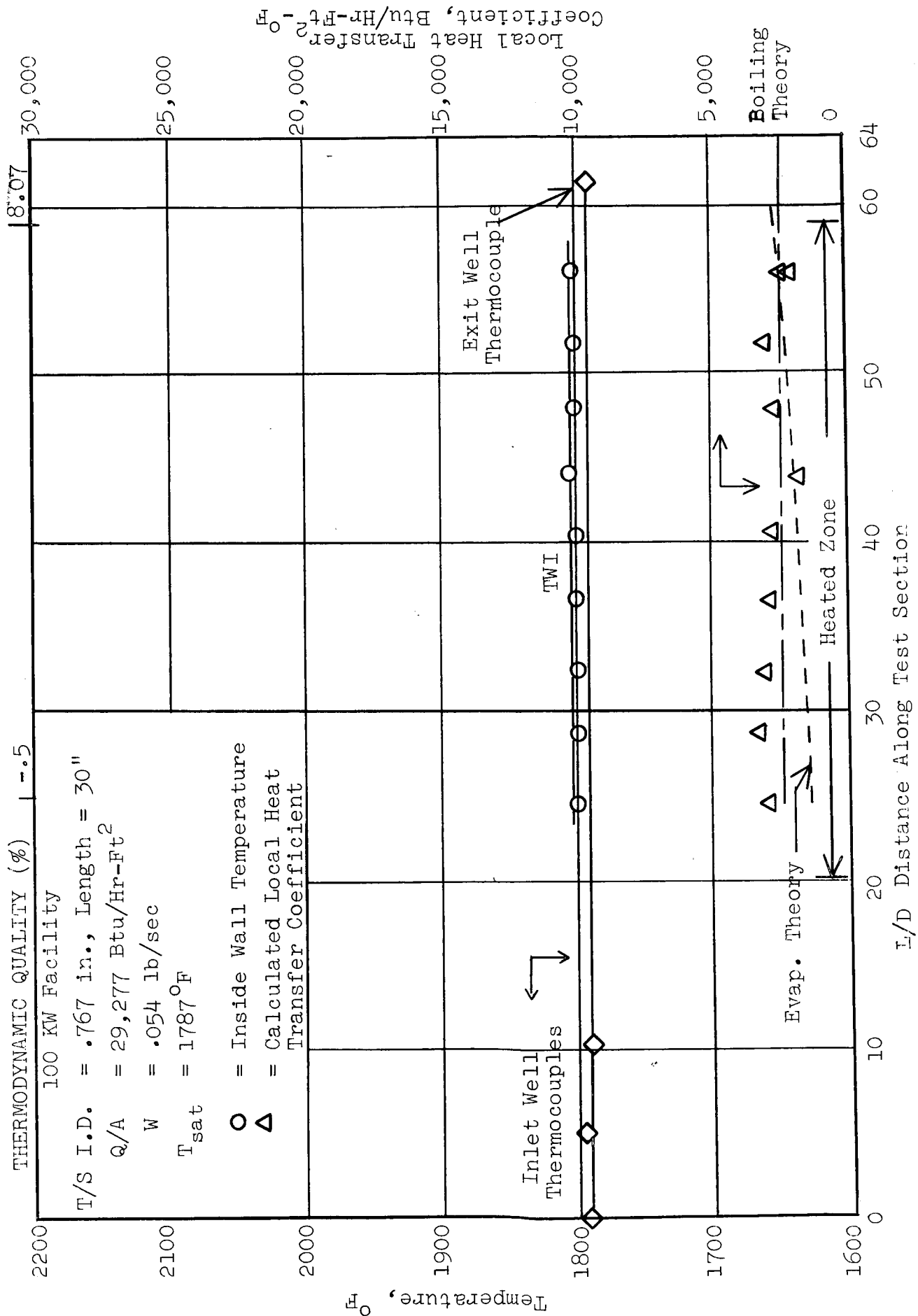
Figure 55a. Forced Convection Vaporization of Potassium at Low Vapor Qualities; $q'' = 29,000$ Btu/hr-ft2 (100 KW Data)

-172-
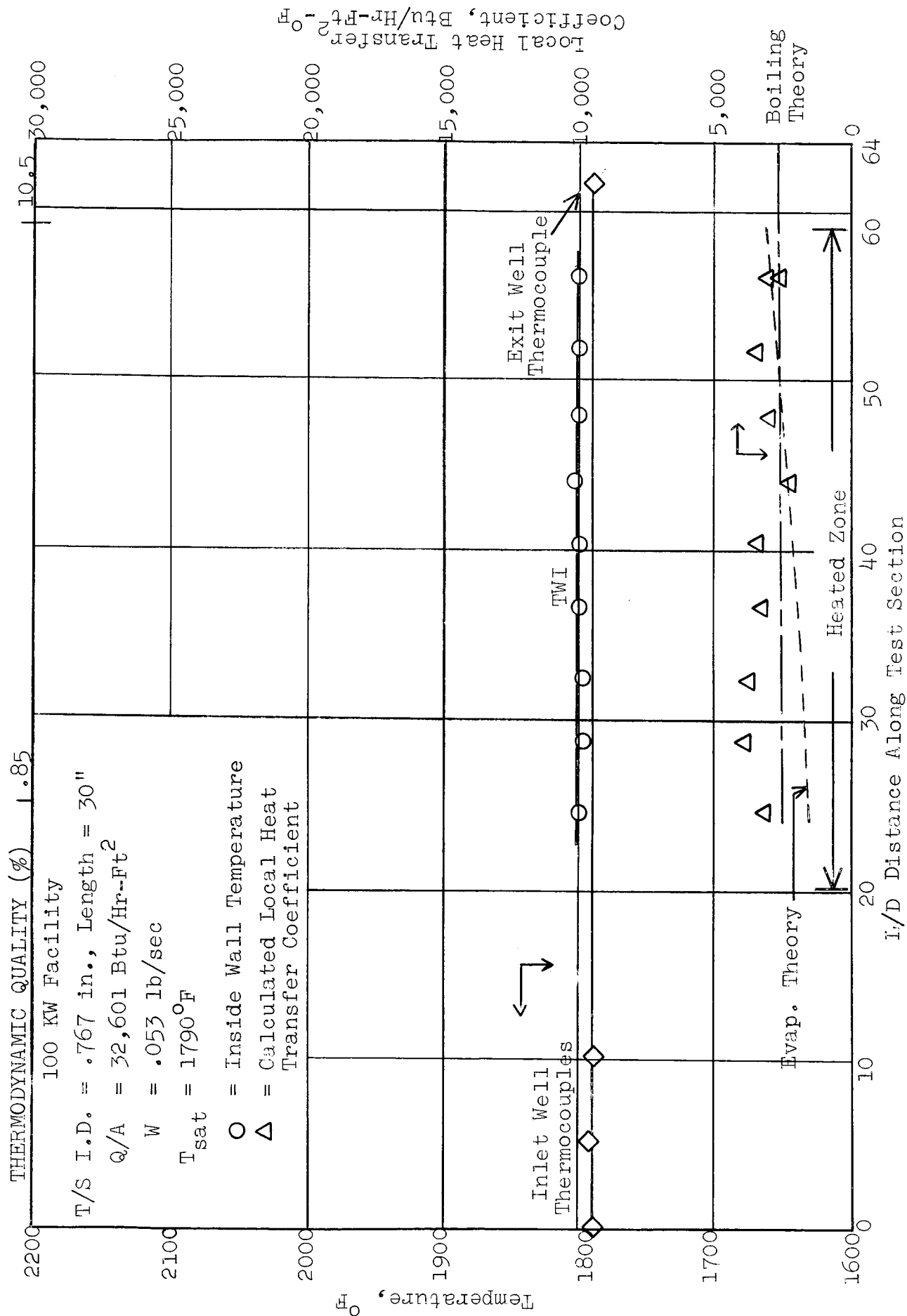
Figure 55b. Forced Convection Vaporization of Potassium at Low Vapor Qualities; q" = 32,000 Btu/hr-ft2 (100 KW Data)
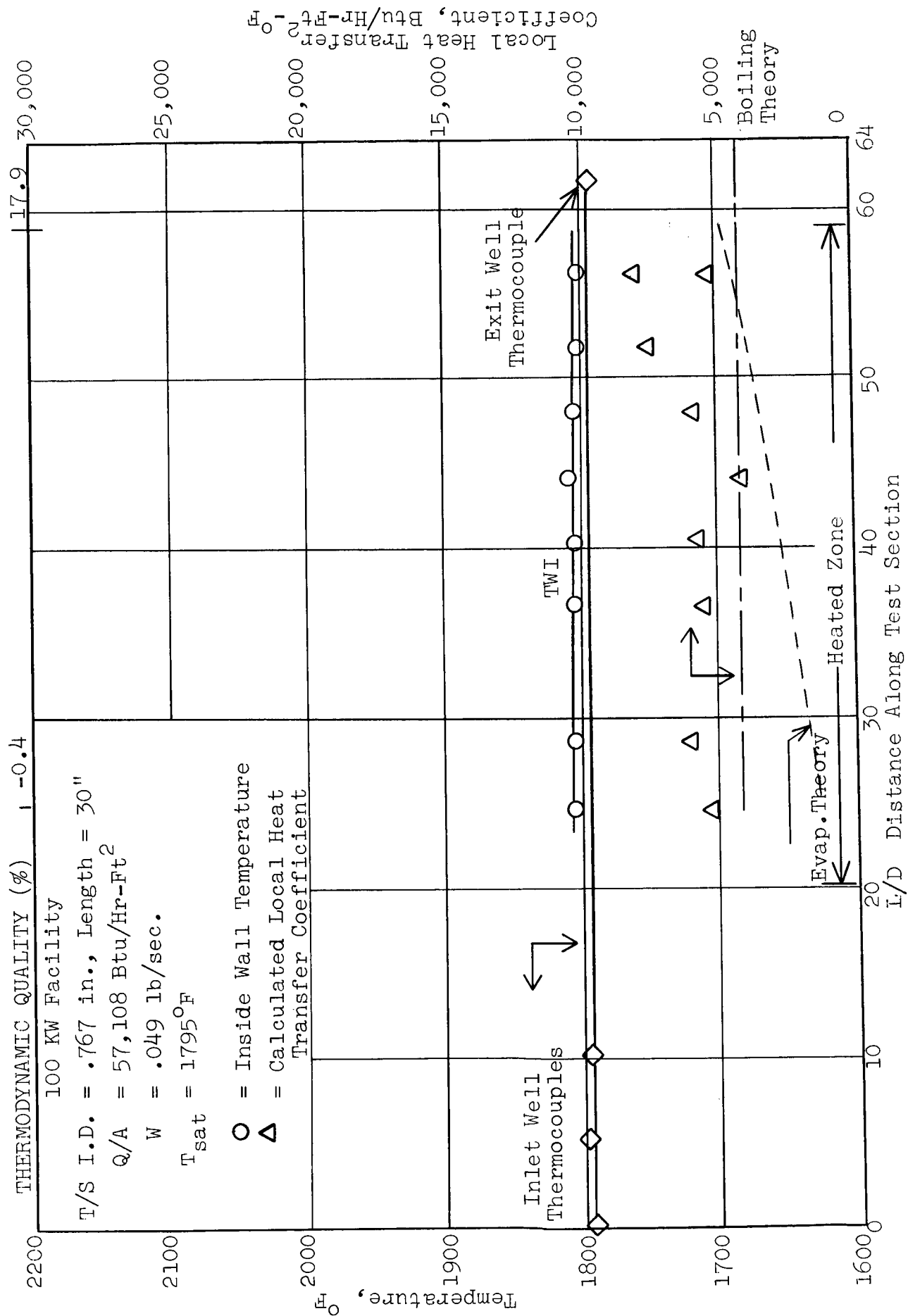
Figure 55c. Forced Convection Vaporization of Potassium at Low Vapor Qualities ; $q'' = 57,000$ Btu/hr-ft2 (100 KW Data)

-174-
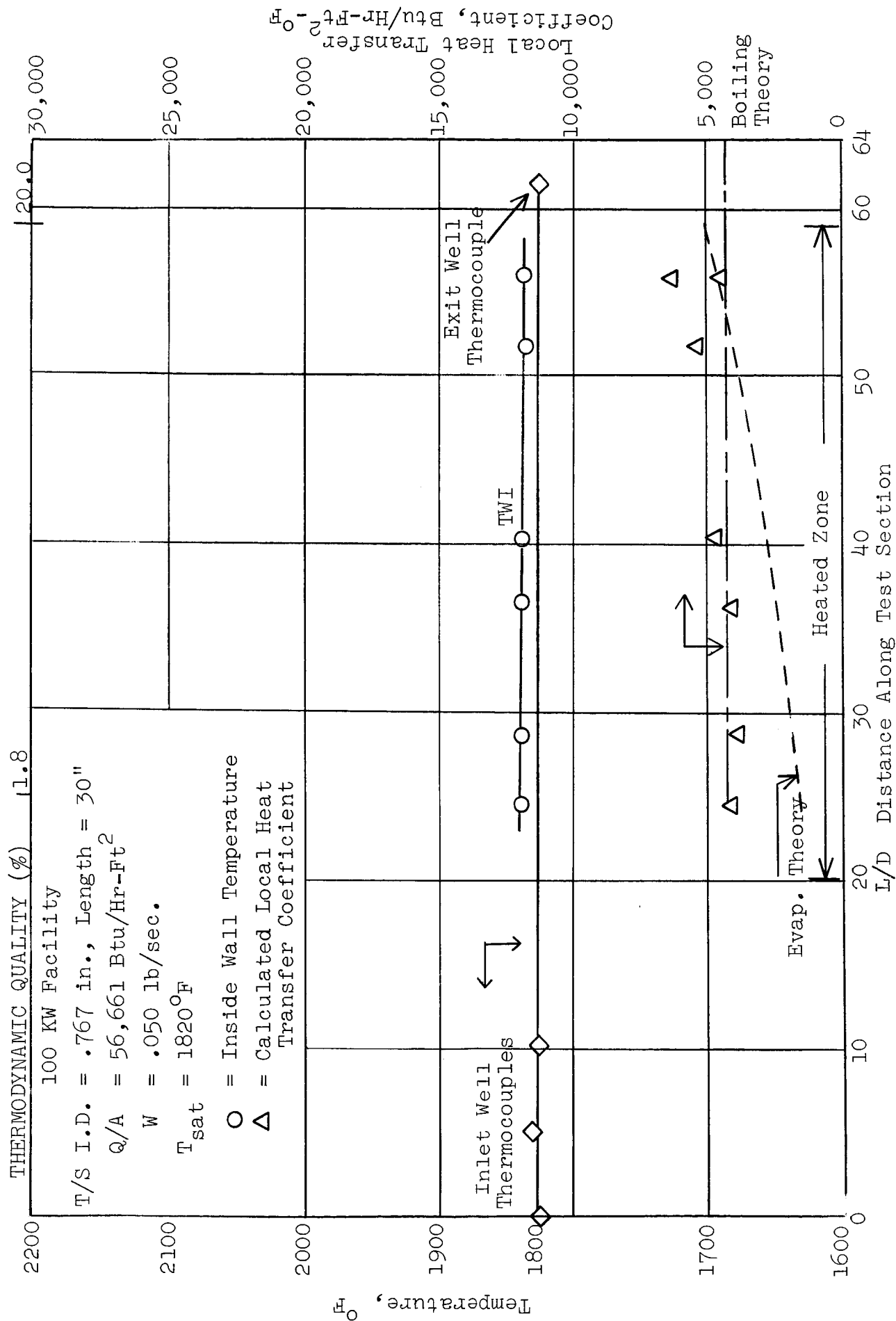
Figure 55d. Forced Convection Vaporization of Potassium at Low Vapor Qualities; $q'' = 56,000$ Btu/hr-ft2 (100 KW Data)
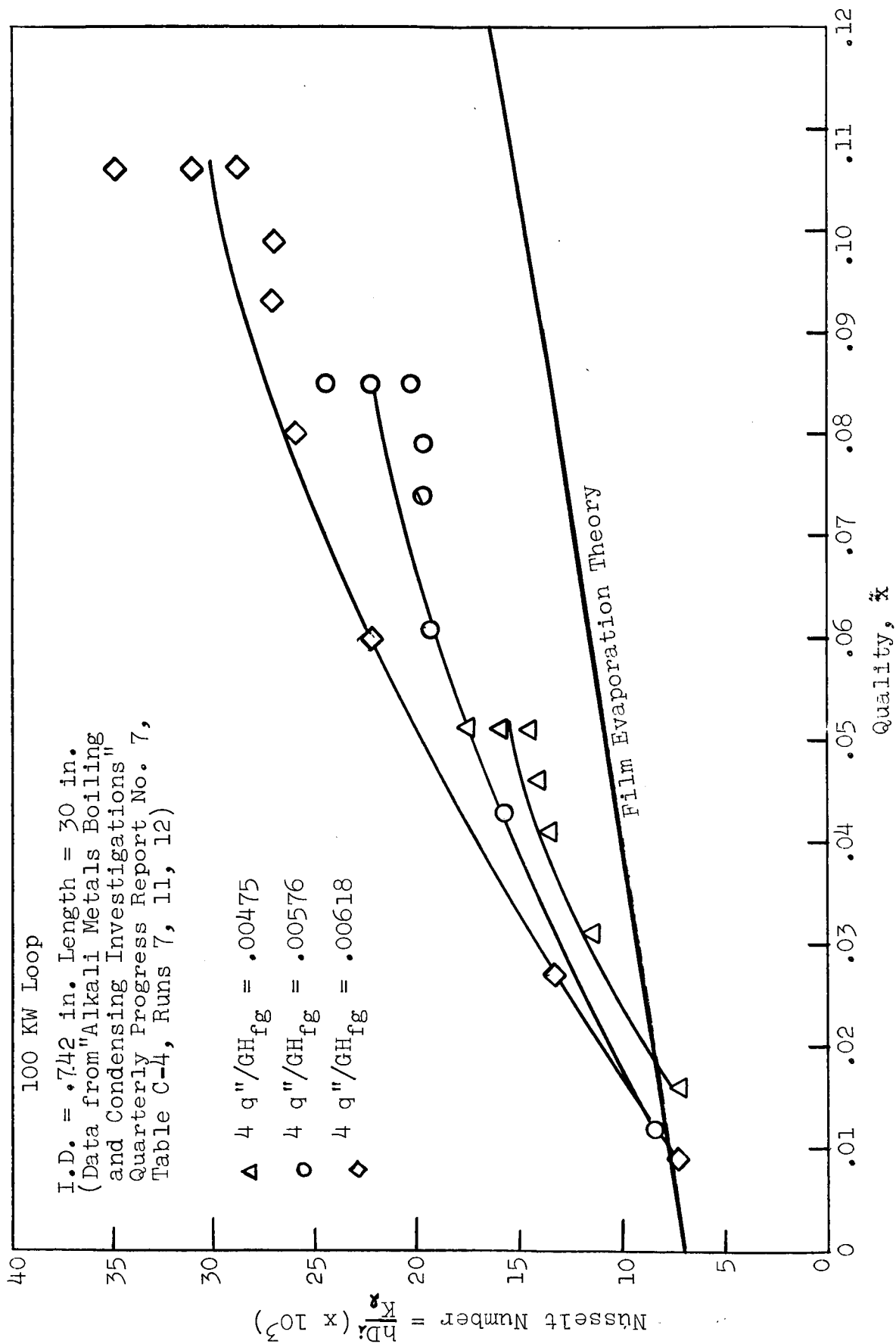
Figure 56. Nusselt Numbers as a Function of Vapor Quality (100 KW Data)
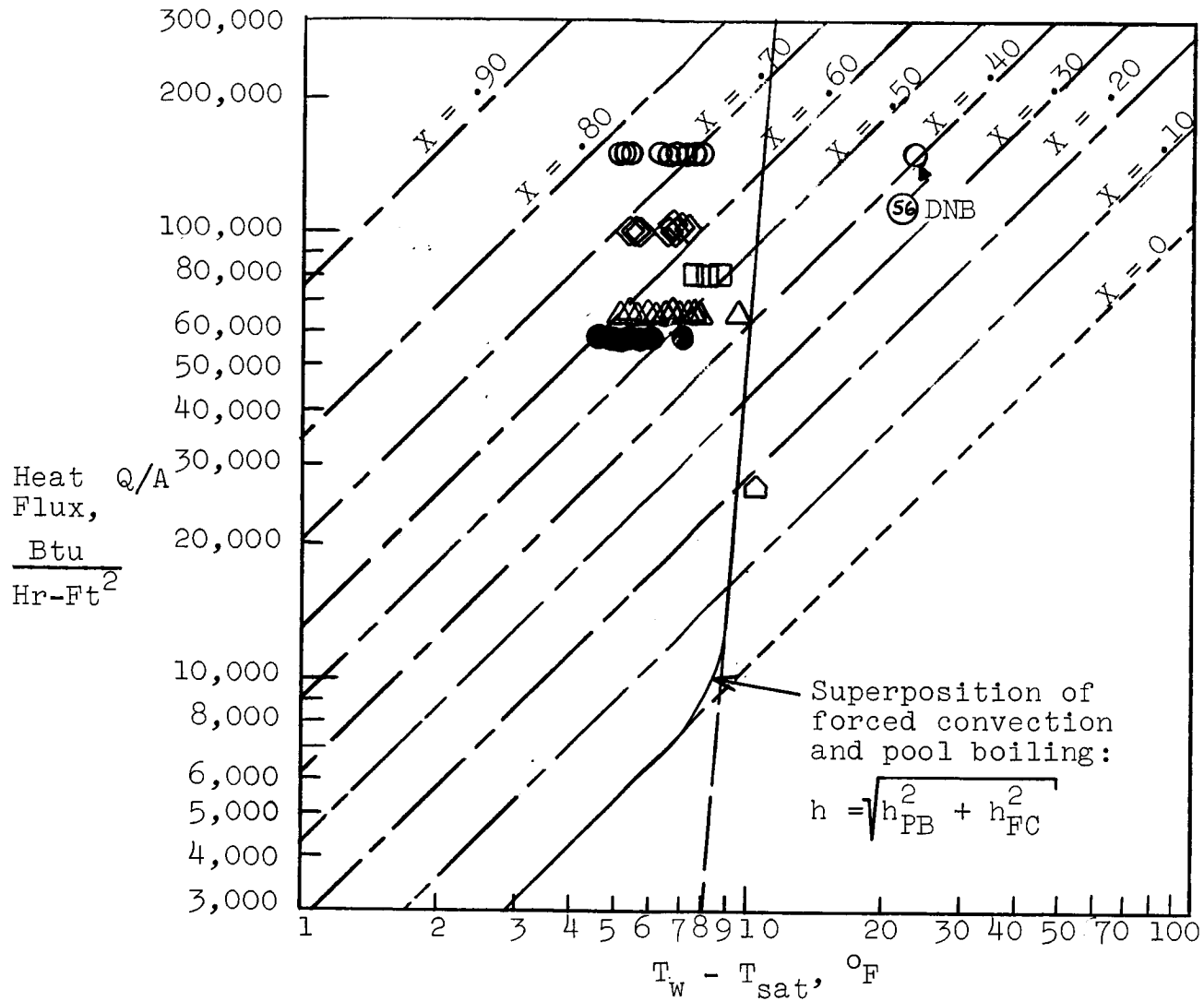
100 KW Data

T_{sat} = 2100°F, ID = .767 in., Length = 30 in.

Ⓝ → = % Quality

10 pts.	○	Q/A = 150,000 Btu/Hr-Ft²,	X = .30 - .56	G = 16 lb/sec-ft²
9 pts.	◇	Q/A = 100,000 Btu/Hr-Ft²,	X = .20 - .37	G = 16 lb/sec-ft²
3 pts.	□	Q/A = 80,000 Btu/Hr-Ft²,	X = .25 - .30	G = 16 lb/sec-ft²
7 pts.	●	Q/A = 58,000 Btu/Hr-Ft²,	X = .22 - .38	G = 16 lb/sec-ft²
1 pt.	△	Q/A = 27,000 Btu/Hr-Ft²,	X = .80,	G = 16 lb/sec-ft²

T_{sat} = 2061°F

14 pts.	△	Q/A = 65,000 Btu/Hr-Ft²,	X = .11 - .37	G = 22 lb/sec-ft²

——— · ——— · ——— Pool Boiling

——————— — — — — Forced Convection

——— — — ——— — Film Evaporation

Figure 57.   Heat Flux as a Function of Temperature Difference
for T_{sat} = 2100°F (100 KW Data) - Reference 7,
-177-   Table C-3
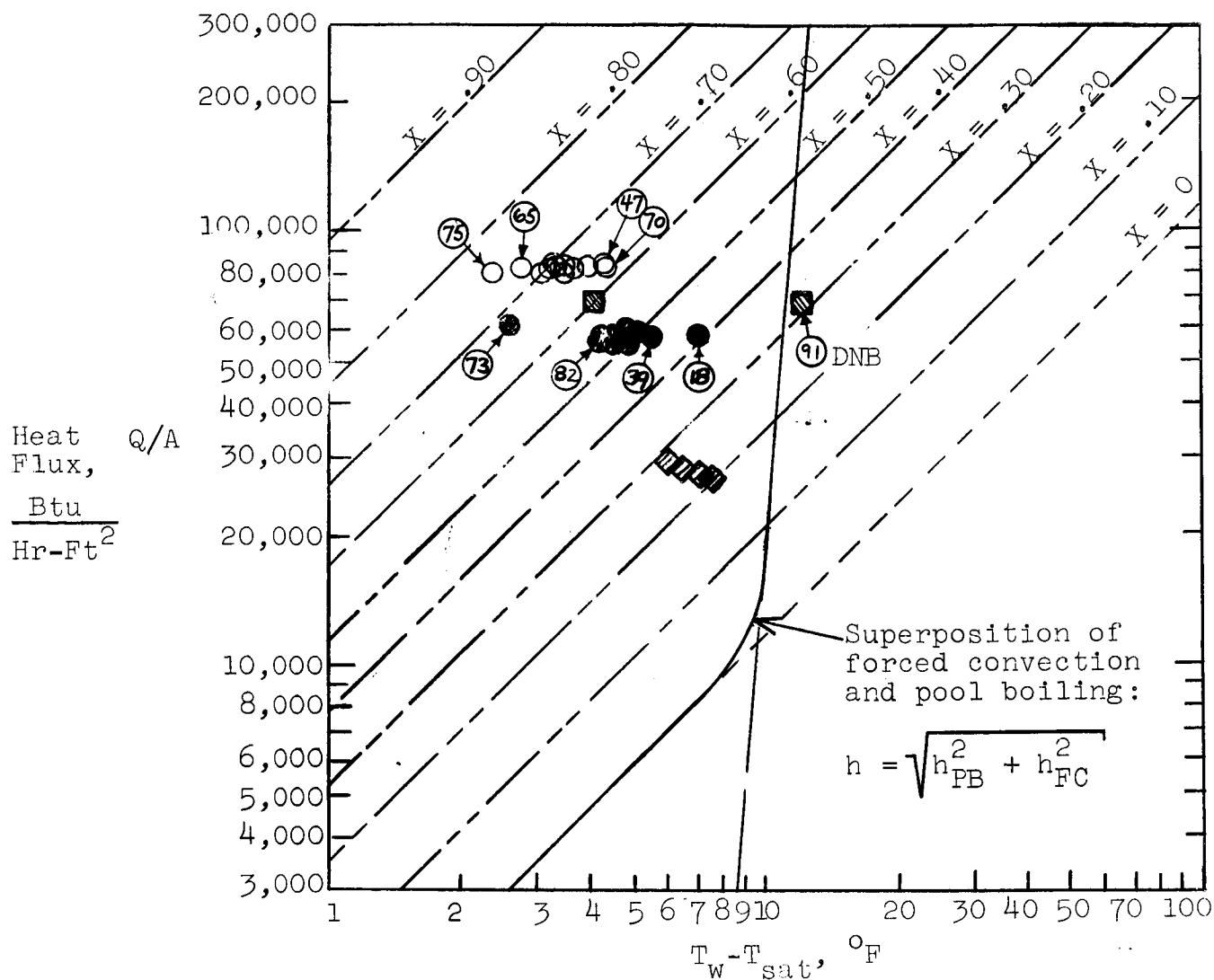
100 KW Data

$T_{sat} = 1990^\circ F$, Test Section I.D. = .767 in., Length = 30 in.

16 pts. O Q/A = 80,000 Btu/hr-ft², X = .46 - .86 G = 16 lb/sec-ft²
 2 pts. ◨ Q/A = 68,000 Btu/hr-ft², X = .82 - .91 G = 16 lb/sec-ft²
13 pts. ● Q/A = 58,000 Btu/hr-ft², X = .18 - .82 G = 16 lb/sec-ft²
 4 pts. ◈ Q/A = 28,000 Btu/hr-ft², X = .68 - .72 G = 16 lb/sec-ft²

Ⓝ = % Quality ——— ——— Pool Boiling
              ——— - - - - — Forced Convection
              ——— - - —— Film Evaporation

Figure 58. Heat Flux as a Function of Temperature Difference
           for T_{sat} = 1990°F (100 KW Data) - Reference 7, Table C-5

100 KW Data

$T_{sat} = 1750°F$, ID = .767 in., Length = 30 in.

8 pts. △ Q/A = 30,000 Btu/Hr-Ft², X = .205 - .357, G = 16 lb/sec-ft²

Pool Boiling

Forced Convection

Film Evaporation
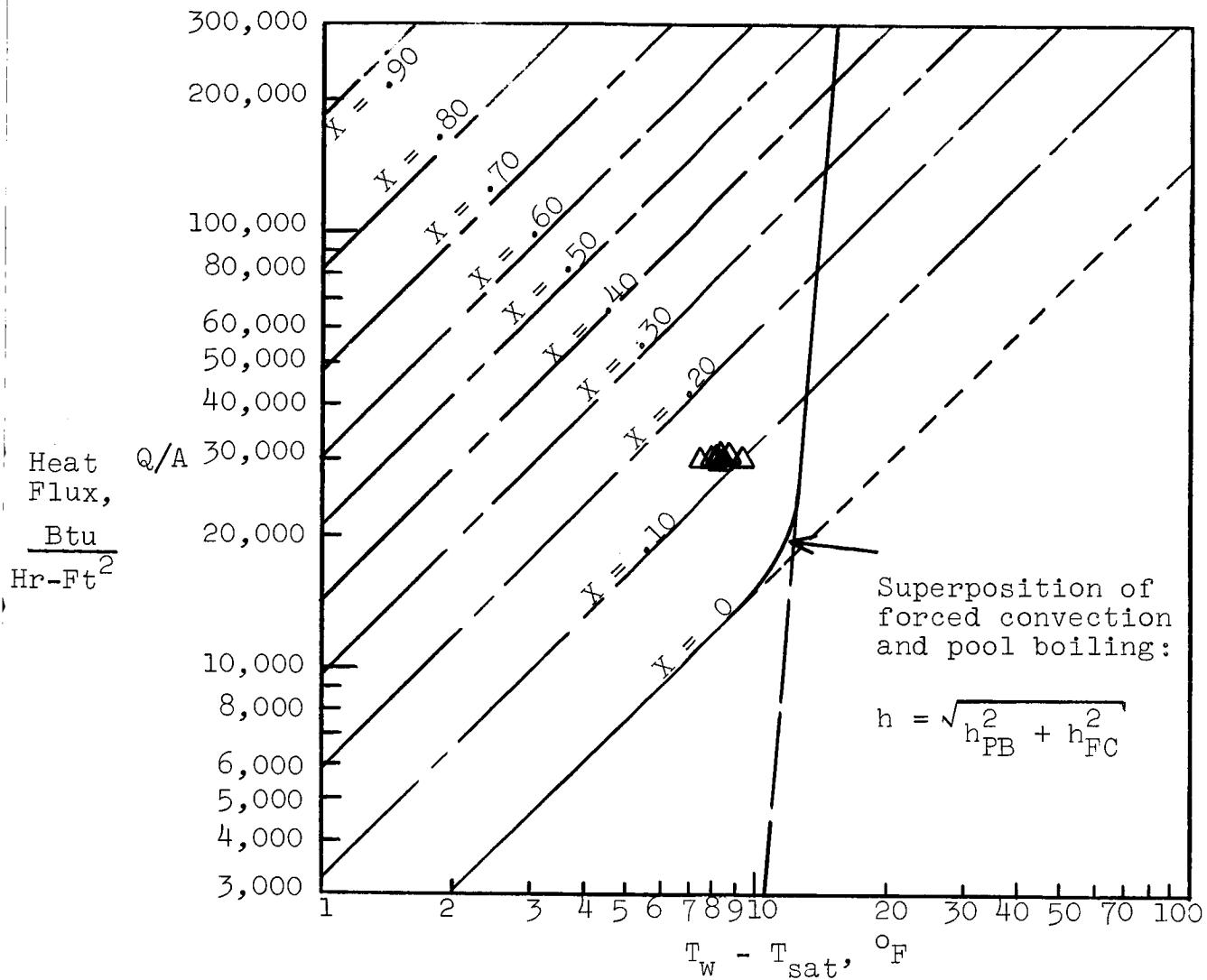
Figure 59. Heat Flux as a Function of Temperature Difference for T_{sat} = 1750°F (100 KW Data) - Reference 7, Table C-3

-179-
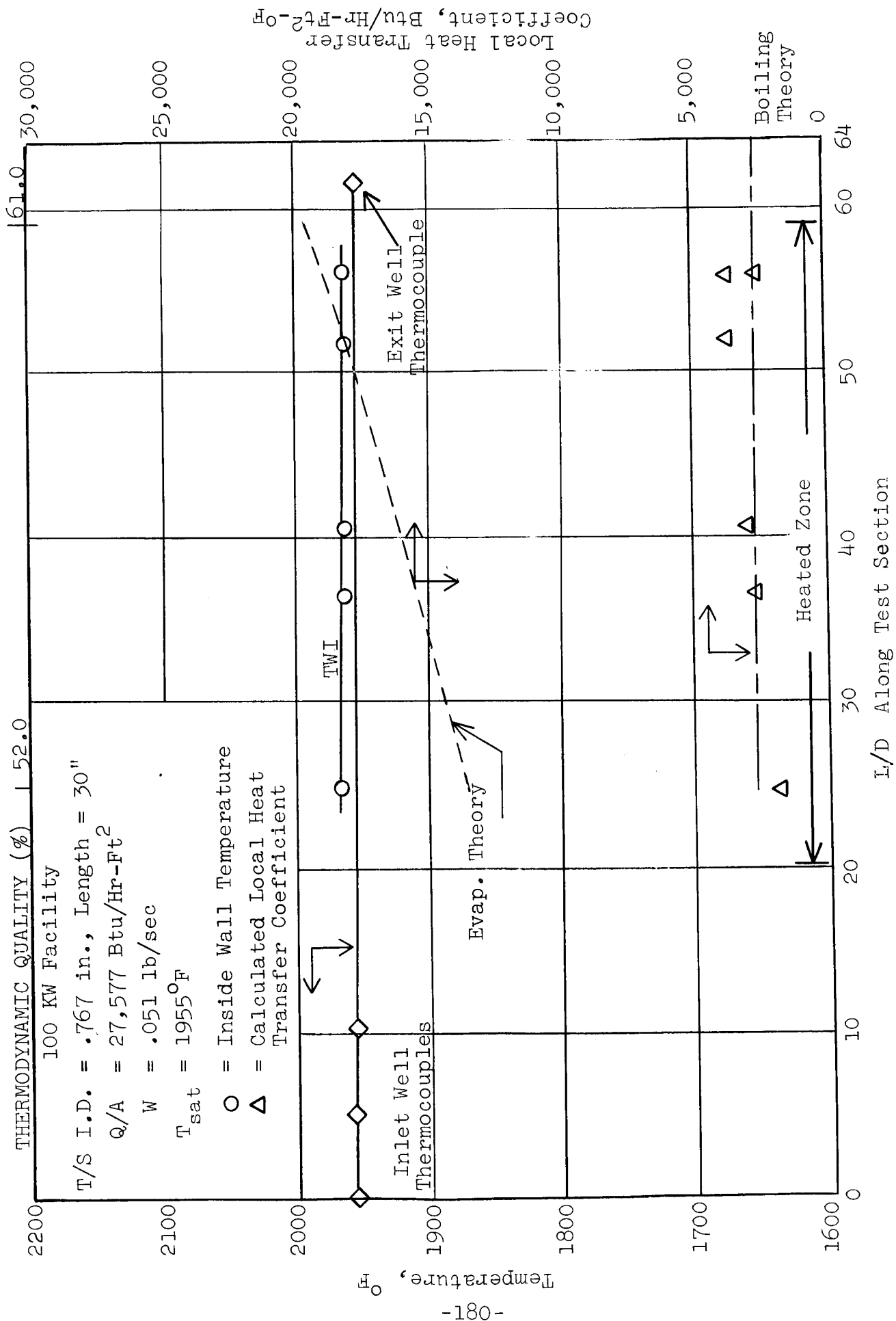
Figure 60a. Forced Convection Vaporization of Potassium at Intermediate Vapor Qualities; q" = 27,000 Btu/hr-ft2 (100 KW Data)
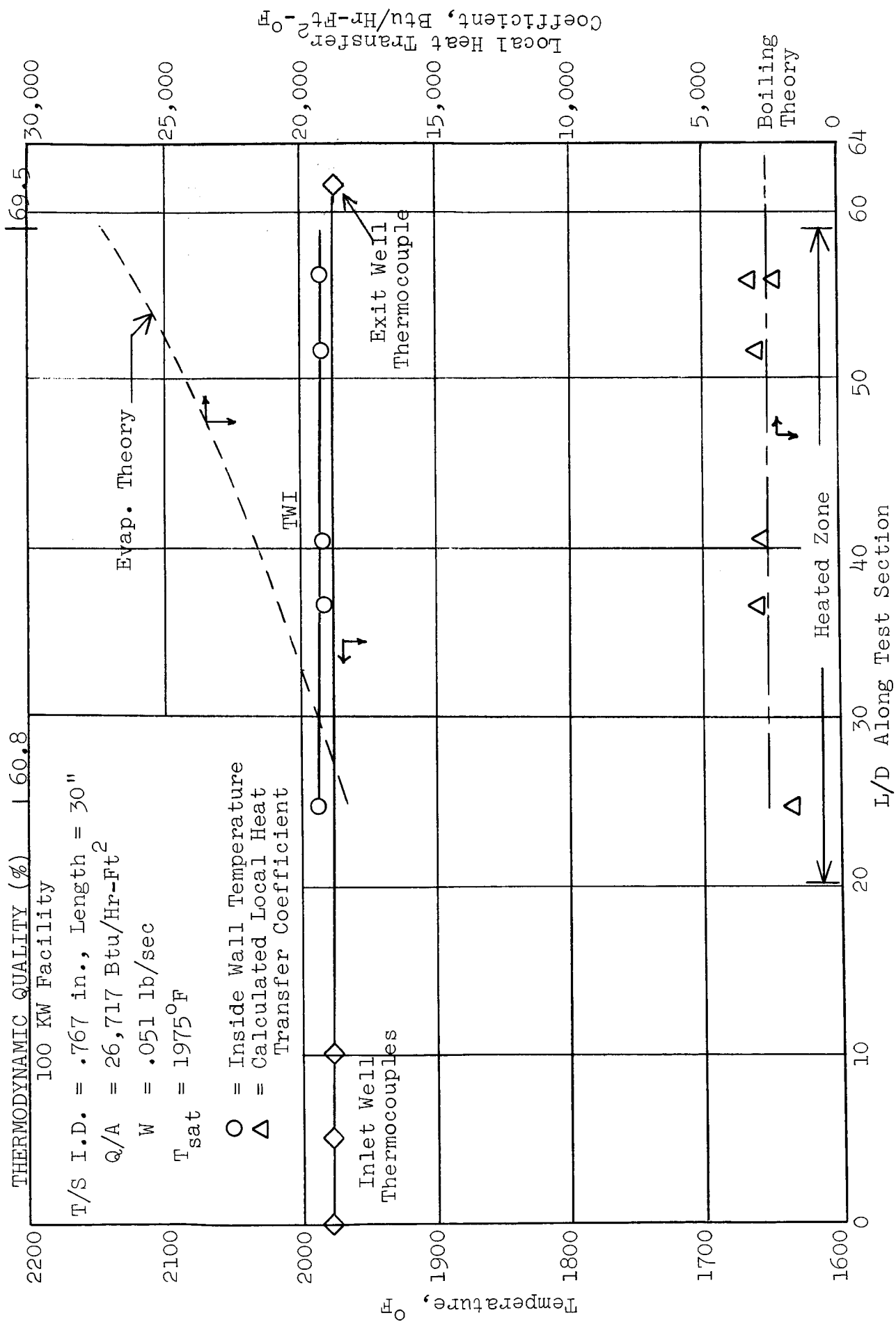
Figure 60b. Forced Convection Vaporization of Potassium at Intermediate Vapor Qualities; $q'' \approx 27,000$ Btu/hr-ft2 (100 KW Data)
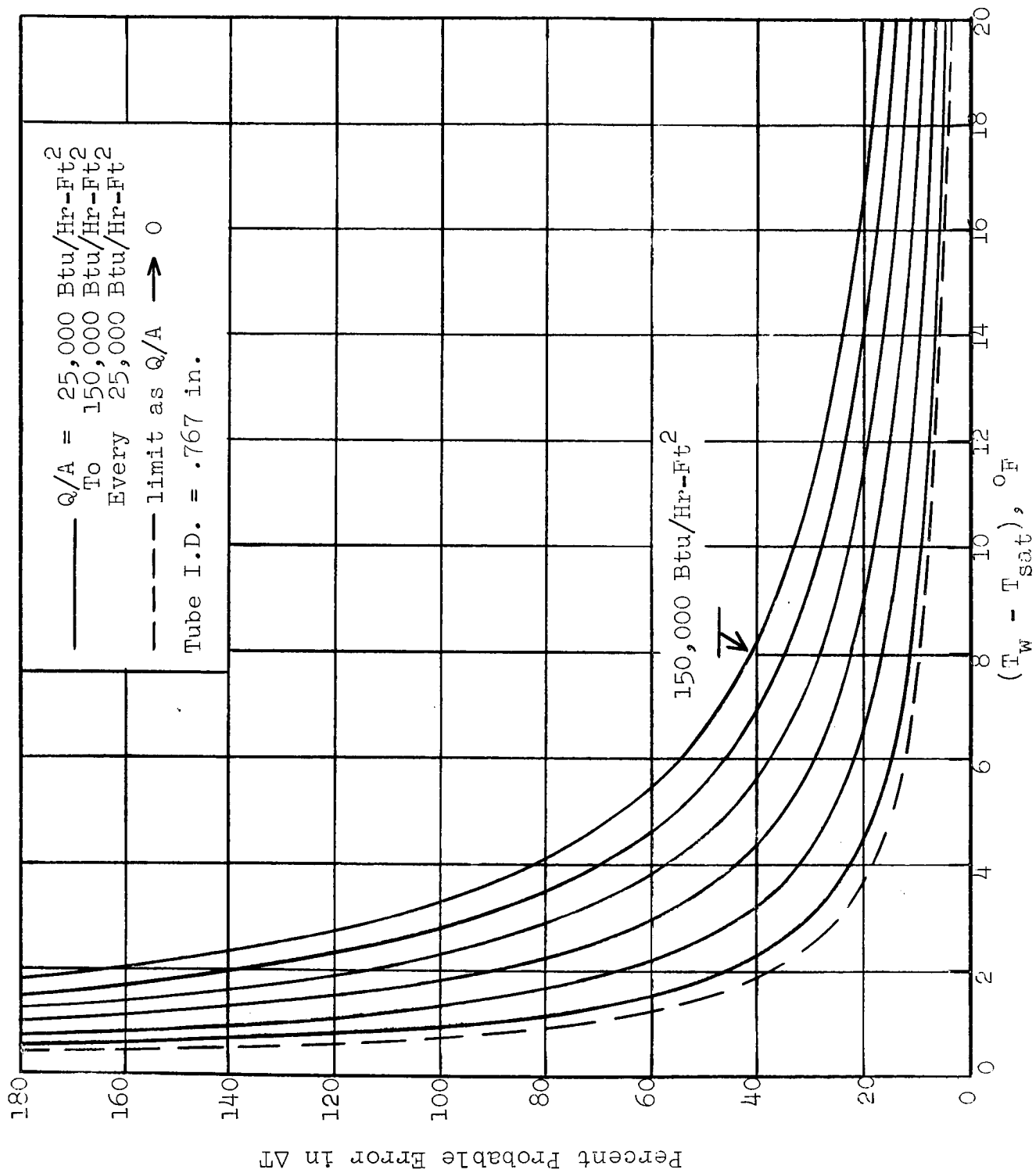
Figure 61a. Percent Probable Error in Inside Wall to Fluid Temperature Difference for the 100 KW Test Section (2 Wall and 3 Fluid Temperature Measurements at a Given Station
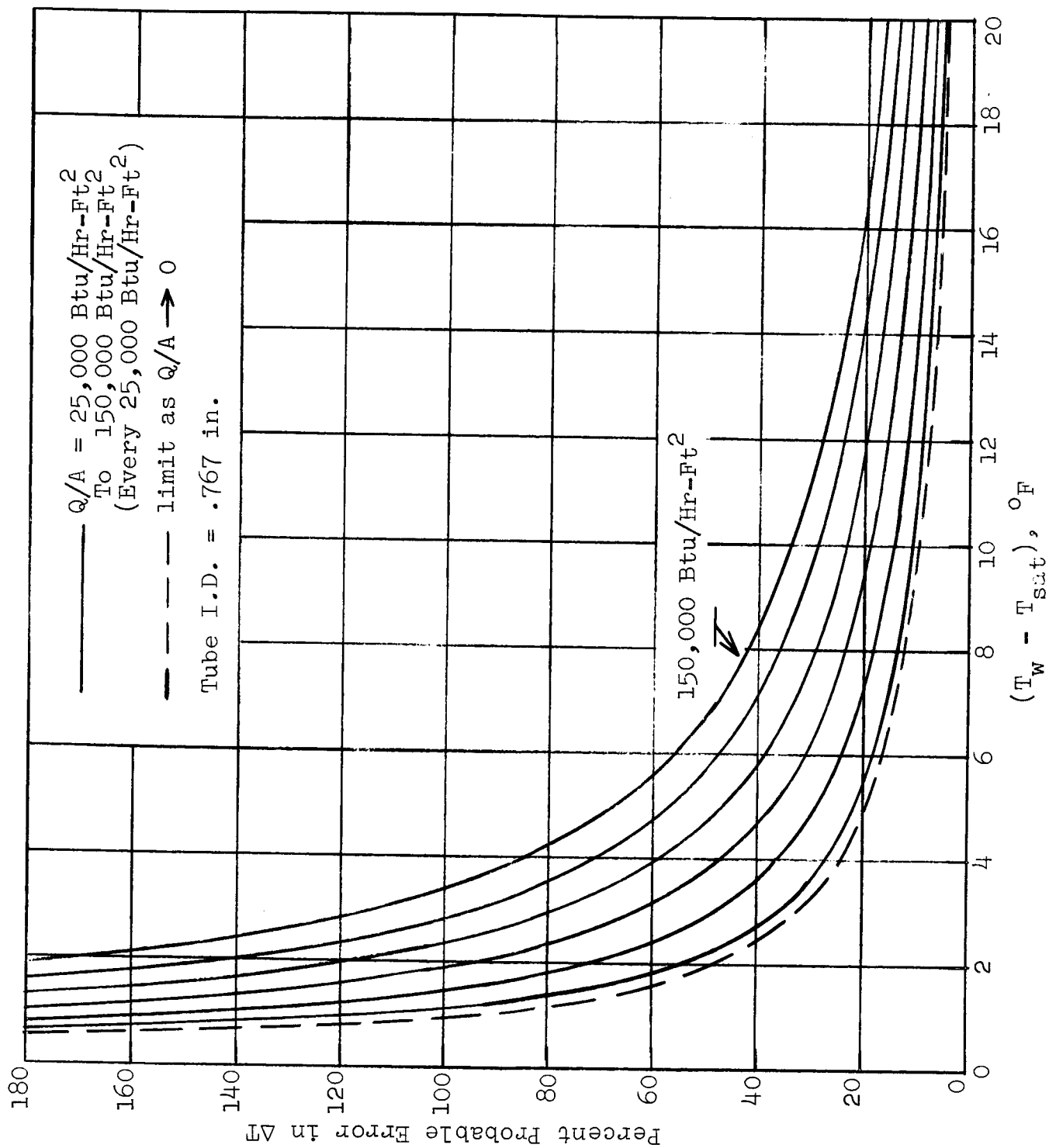
Figure 61b. Percent Probable Error in Inside Wall to Fluid Temperature Difference for the 100 KW Test Section (1 Wall and 3 Fluid Temperature Measurements at a Given Station
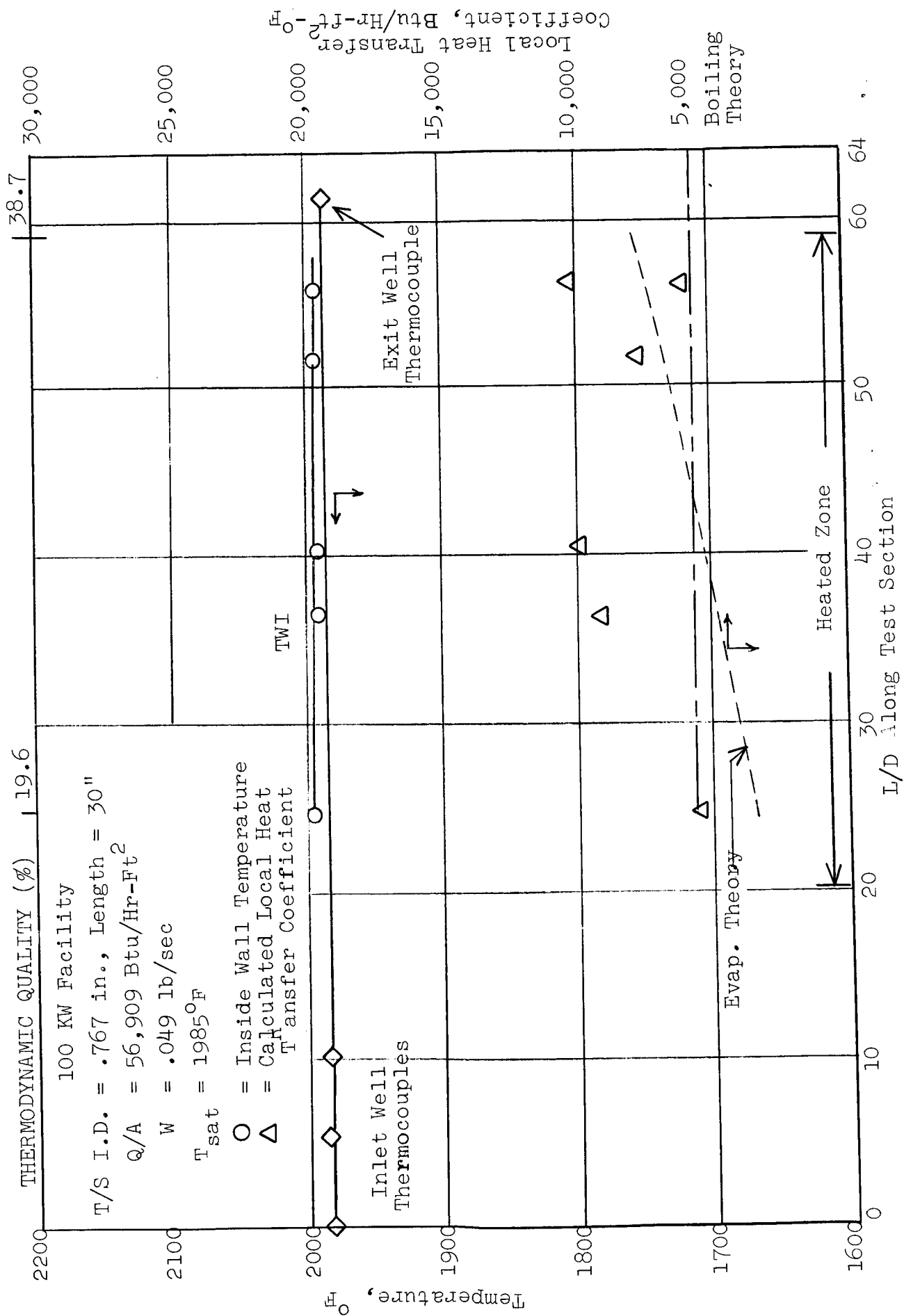
Figure 62a. Forced Convection Vaporization of Potassium at Intermediate Vapor Qualities; q" = 57,000 Btu/hr-ft2 (100 KW Data)

-184-
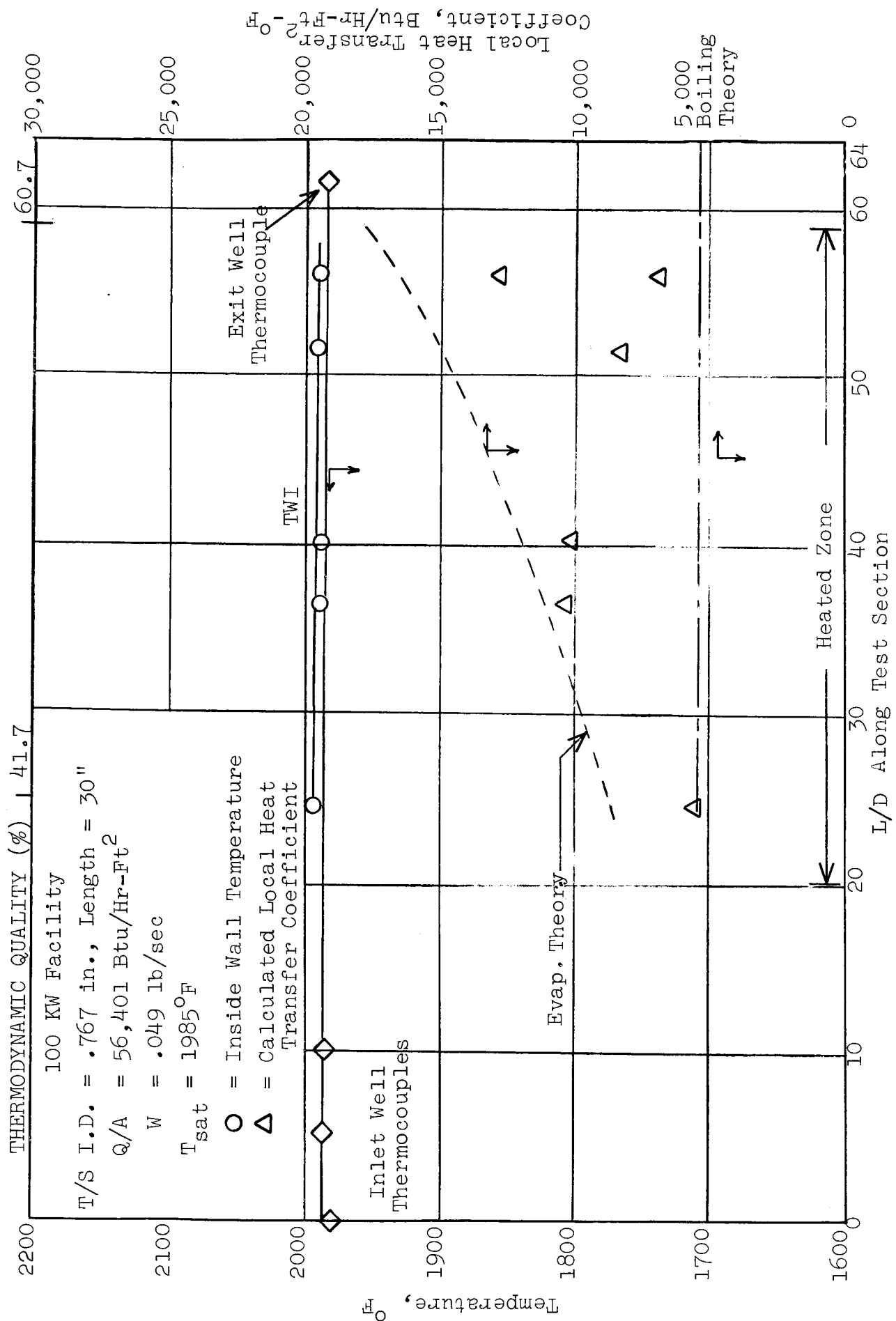
Figure 62b. Forced Convection Vaporization of Potassium at Intermediate Vapor Qualities;
q" = 56,000 Btu/hr-ft2 (100 KW Data)
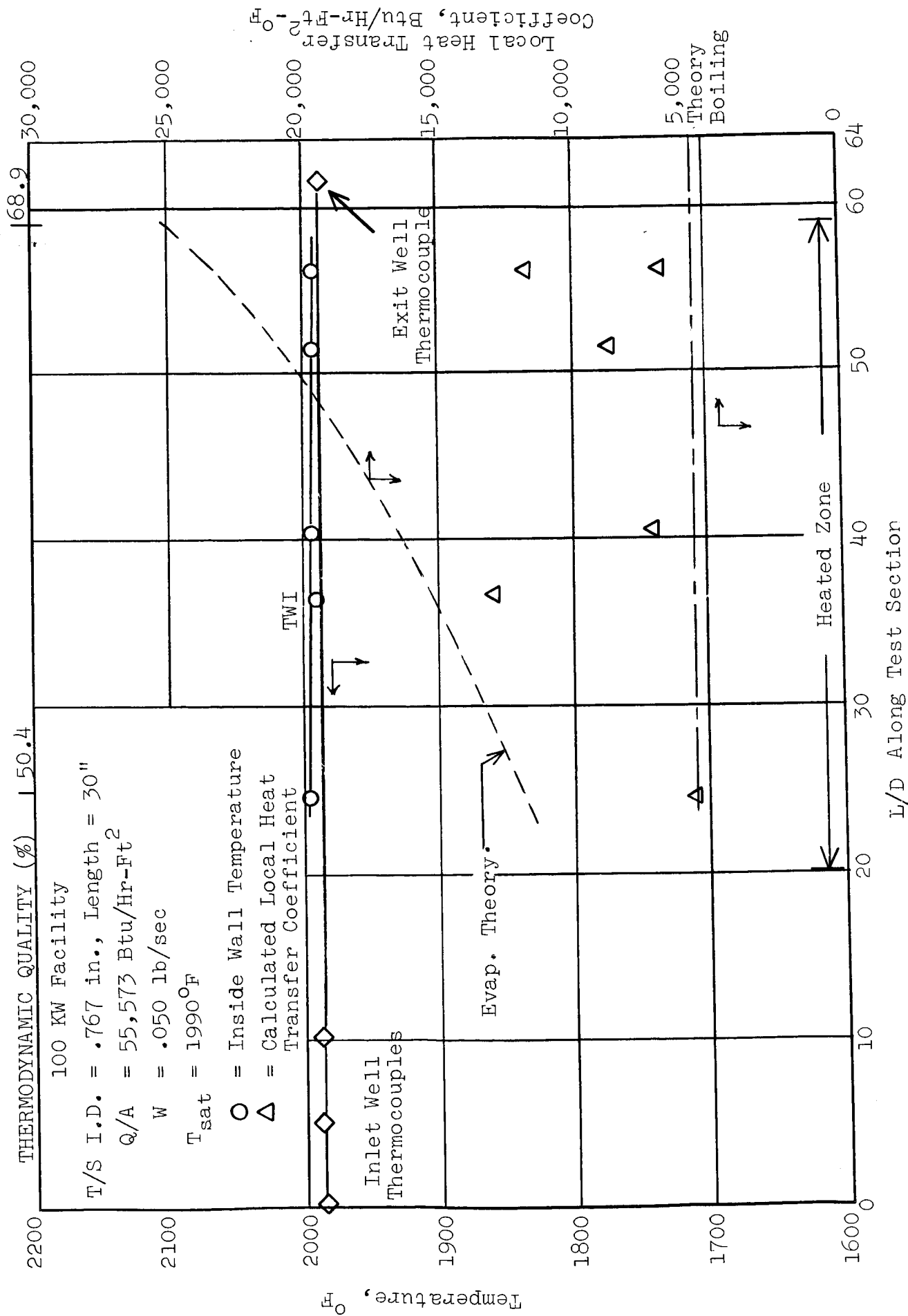
Figure 62c. Forced Convection Vaporization of Potassium at Intermediate Vapor Qualities;
q" = 55,000 Btu/hr-ft2 (100 KW Data)

-186-
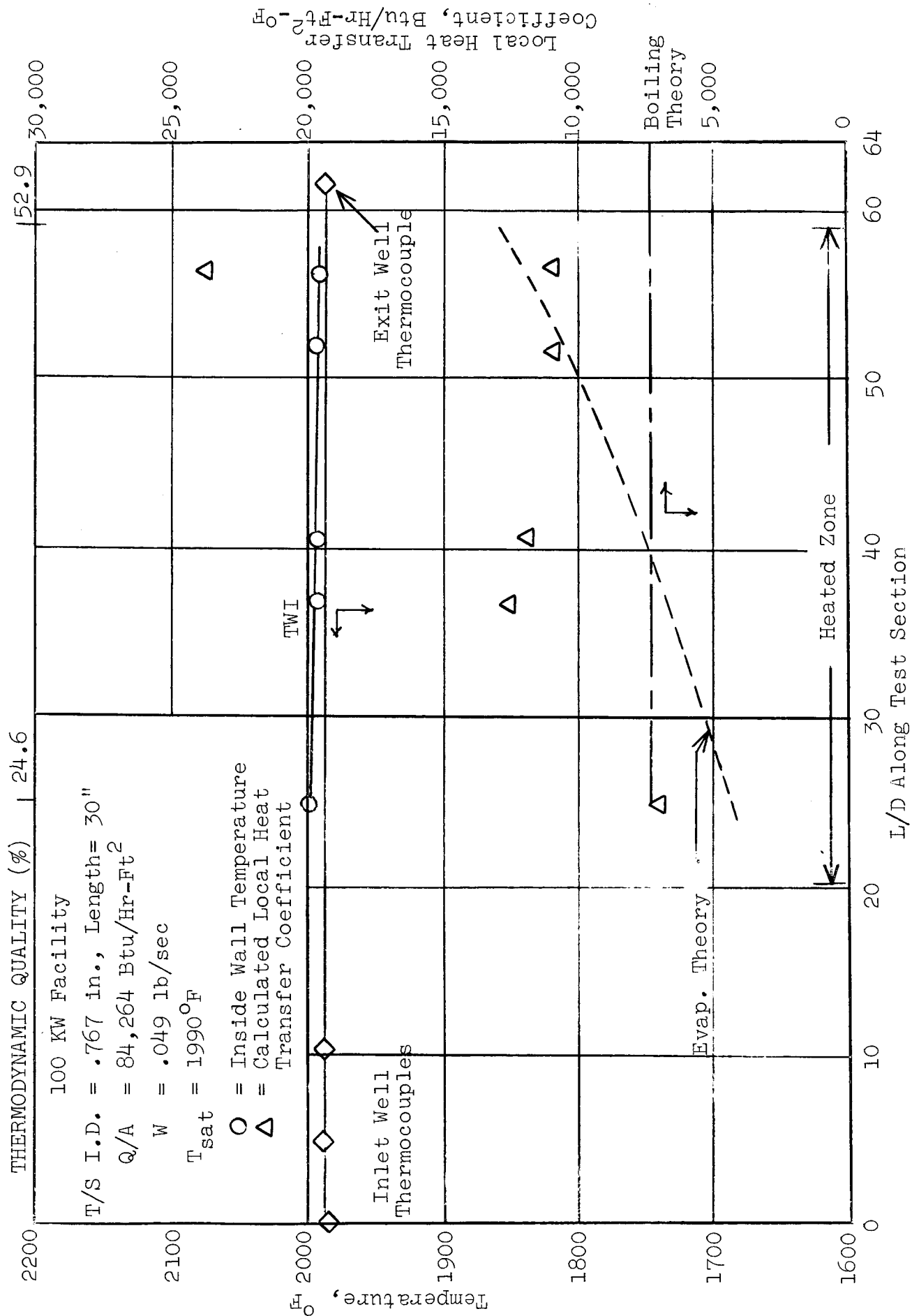
Figure 62d. Forced Convection Vaporization of Potassium at Intermediate Vapor Qualities; q" = 84,000 Btu/hr-ft2 (100 KW Data.)
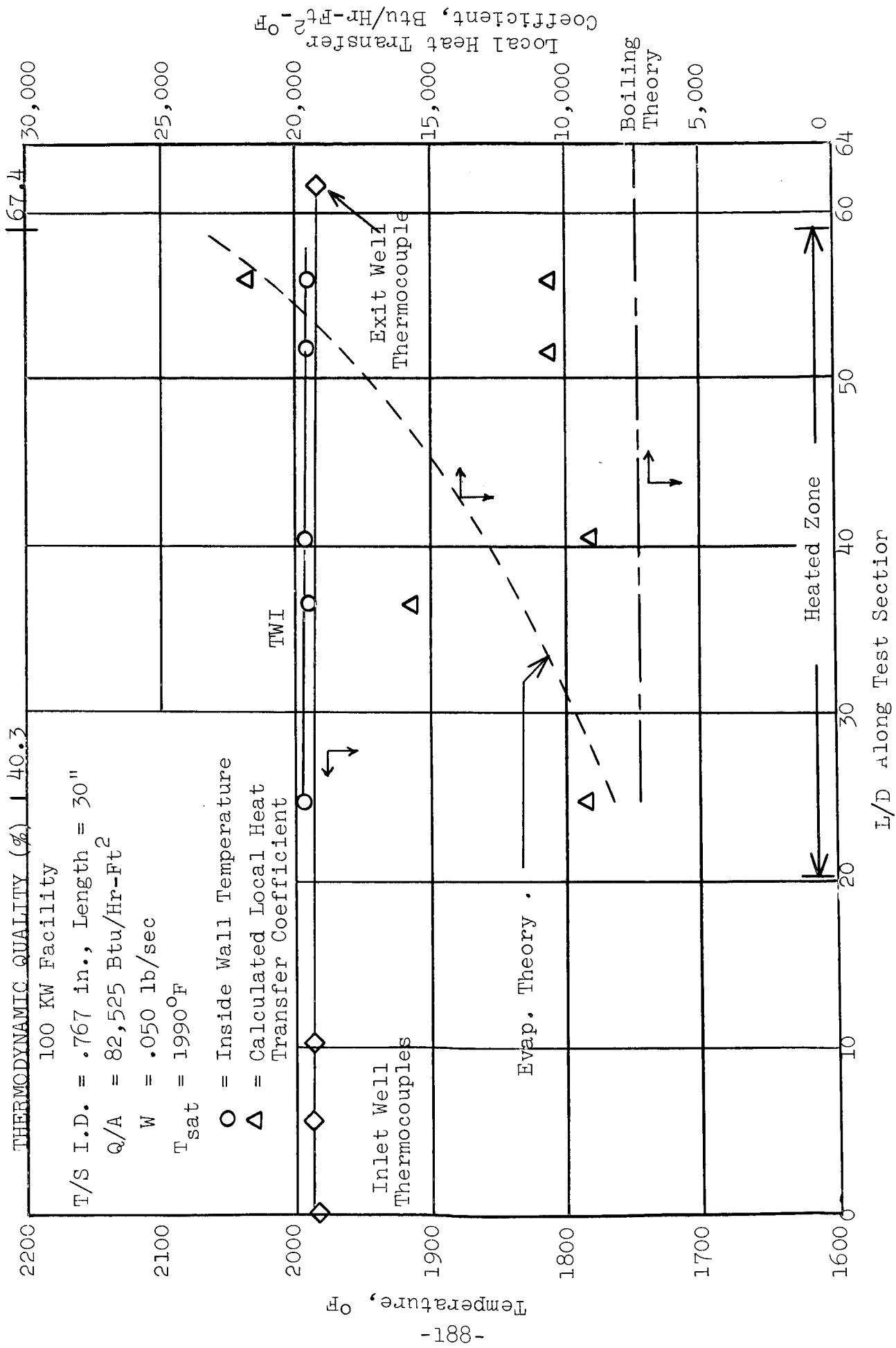
Figure 62a. Forced Convection Vaporization of Potassium at Intermediate Vapor Qualities; q" = 82,000 Btu/hr-ft2 (100 KW Data)

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APPENDIX A

DERIVATION OF HELIX EQUATIONS - 300 KW PROJECT

J. R. Peterson

Derivation of Helix Equations

Definition of Helix

The cylindrical helix is the path of a point which moves around the surface of a right circular cylinder with a constant angular velocity w and at the same time moves parallel to the axis of the cylinder with a constant linear or axial velocity V_a. The pitch (P) of the helix is the axial distance traveled for an angular displacement of 2π radians.

Derivation of Helical Path Length and Helical Velocity:
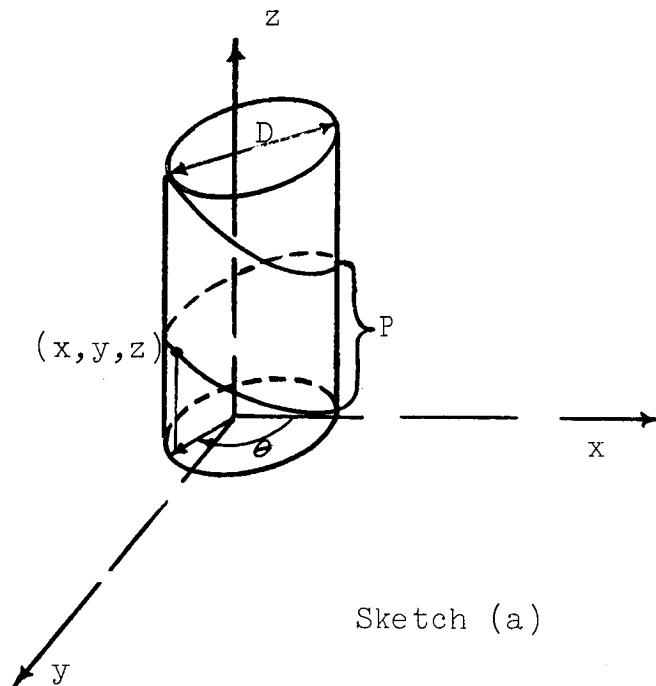
Sketch (a)

Sketch (a) above illustrates the helical path. From the drawing, the co-ordinates x, y and z are given as follows in terms of the angular displacement θ the time t and the helix diameter D:

$$x = D/2 \cos\theta \qquad\qquad (1)$$

$$y = D/2 \sin\theta \qquad\qquad (2)$$

$$z = V_a t \qquad\qquad (3)$$

$$\theta = wt \qquad\qquad (4)$$

From equations (3) + (4):

$$t = z/V_a = \theta/w \qquad\qquad (5)$$

The arc length s along a three dimensional curve is given as follows:

$$s = \int \sqrt{dx^2 + dy^2 + dz^2} \qquad\qquad (6)$$

In terms of the parameter θ ,

$$s = \int \sqrt{\left(\frac{dx}{d\theta}\right)^2 + \left(\frac{dy}{d\theta}\right)^2 + \left(\frac{dz}{d\theta}\right)^2} \, d\theta \qquad (7)$$

From equations (1) and (2):

$$\frac{dx}{d\theta} = - D/2 \sin\theta \qquad\qquad (8)$$

$$\frac{dy}{d\theta} = D/2 \cos\theta \qquad\qquad (9)$$

$$\left(\frac{dx}{d\theta}\right)^2 + \left(\frac{dy}{d\theta}\right)^2 = \frac{D^2}{4} (\sin^2\theta + \cos^2\theta) = D^2/4 \qquad (10)$$

From equation (5)

$$z = \frac{V_a}{w} \qquad\qquad (11)$$

In the time required for 2π angular displacement, an axial length $z = P$ is traveled, therefore from equation (5):

$$P = \frac{2\pi V_a}{w} \text{ , or } \frac{V_a}{w} = \frac{P}{2\pi} \qquad (12)$$

From equations (11) and (12):

$$\frac{dz}{d\Theta} = P/2\pi \qquad (13)$$

Combining equations (7), (8), (9) and (13) to obtain the helical path length L_H:

$$s = \int \sqrt{D^2/4 + \frac{P^2}{4\pi^2}} \, d\Theta = L_H \qquad (14)$$

Upon integrating equation (14) over the angular displacement 0 to 2π radians, and recognizing that the axial length L traversed for a 2π angular displacement is P, we obtain:

$$\frac{L_H}{L} = \frac{L_H}{P} = \sqrt{1 + \left(\frac{\pi D}{P}\right)^2} \qquad (15)$$

The helical velocity V_H is obtained by dividing the helical path length for 2π revolutions by the time required by 2π revolutions as follows; using equations (5) and (15):

$$V_H = \frac{L_H}{\frac{2\pi}{w}} = \frac{P\sqrt{1 + \left(\frac{\pi D}{P}\right)^2}}{(P/V_a)} \qquad (16)$$

$$\frac{V_H}{V_a} = \sqrt{1 + (\frac{\pi D}{P})^2} \qquad (17)$$

Tangential Velocity:

In the time P/V_a required for 2π revolutions, a circumferential distance of πD is traversed. The circumferential or tangential component of the helical velocity V_T is therefore given as follows:

$$V_T = \frac{\pi D}{P/V_a} \qquad (18)$$

$$V_T/V_a = \frac{\pi D}{P} \qquad (19)$$

Axial Flow Area and Equivalent Diameter:

The axial flow area A_F perpendicular to the axis of a tube containing a helical insert is given as follows, where D_i is the tube inside diameter, D_{cb} the helix centerbody diameter and Δ is the thickness of the tape wound around the centerbody:

$$A_F = \frac{\pi}{4} \left[D_i^2 - D_{cb}^2 \right] - \frac{[D_i - D_{cb}]\Delta}{2.0} \qquad (20)$$

The wetted perimeter P_w encountered by the axial flow is as follows:

$$P_w = \pi (D_i + D_{cb}) + D_i - D_{cb} - 2\Delta \qquad (21)$$

The equivalent diameter, D_e, of the tube containing helical insert from the flow area and wetted perimeter is given as follows:

$$D_e = \frac{4A_F}{P_w} = \frac{D_i \left[1 - (\frac{D_{cb}}{D_i})^2 - \frac{2\Delta}{\pi} (\frac{1}{D_i} - \frac{D_{cb}}{D_i^2}) \right]}{1 + \frac{D_{cb}}{D_i} + (1 - \frac{D_{cb}}{D_i} - \frac{2\Delta}{D_i}) \frac{1}{\pi}} \qquad (22)$$

Neglecting the tape width Δ, equation (23) following is obtained:

$$D_e/D_i = \frac{1 - (\frac{D_{cb}}{D_i})^2}{1 + \frac{D_{cb}}{D_i} + \frac{1}{\pi}(1 - \frac{D_{cb}}{D_i})} \qquad (23)$$

Radial Acceleration Developed by the Insert:

A parameter of interest in the analysis of the experimental boiling data is the radial acceleration developed by the insert in two phase flow in the thin liquid film at the tube wall. An expression for this radial acceleration a, expressed as a multiple of the standard gravitational acceleration g, is obtained as follows. Assuming that the liquid fraction in two phase potassium flow occupies a negligible fraction of the flow area, the axial vapor velocity V_{ag} is given by equation (24) in terms of the total mass flow rate W, or axial mass velocity G_a:

$$V_{ag} = \frac{XW}{\rho_g A_F} = \frac{XG_a}{\rho_g} \qquad (24)$$

Using the ratio of vapor to liquid velocities K and equation (19), the tangential liquid velocity at the tube wall V_{fT} is obtained as follows:

$$V_{fT} = \frac{V_{ag}}{K} \frac{\pi D_i}{P} = \frac{XG_a}{\rho_g K} \frac{\pi D_i}{P} \qquad (25)$$

The radial acceleration a in the liquid film at the tube wall is finally obtained as follows:

$$a = \frac{2V_{fT}^2}{D_i g} = \frac{2}{D_i g} \left(\frac{XG_a}{\rho_g K} \frac{\pi D_i}{P}\right)^2 \qquad (26)$$

APPENDIX B

100 KW DATA

100 KW LOOP TEST SECTION INSTRUMENTATION FOR DATA TAKEN BETWEEN 2-25-65 AND 4-1-65

T/C No.	Location	Distance Inches
	Start of Heated Zone	15 1/4
20	Test Section Wall	20 7/16
21	Test Section Wall	20 1/2
22	Test Section Wall	30
23	Test Section Wall	30
24	Test Section Wall	41 5/8
25	Test Section Wall	41 5/8
26	Test Section Wall	43 3/4
27	Test Section Wall	43 5/8
31	Test Section Wall	43 9/16
32	Test Section Wall	43 5/8
	End of Heated Zone	45 1/4
33	Test Section Outlet Well	47
34	Test Section Outlet Well	47
35	Test Section Outlet Well	47

Test Section I.D. = 0.423 inches,
No Insert
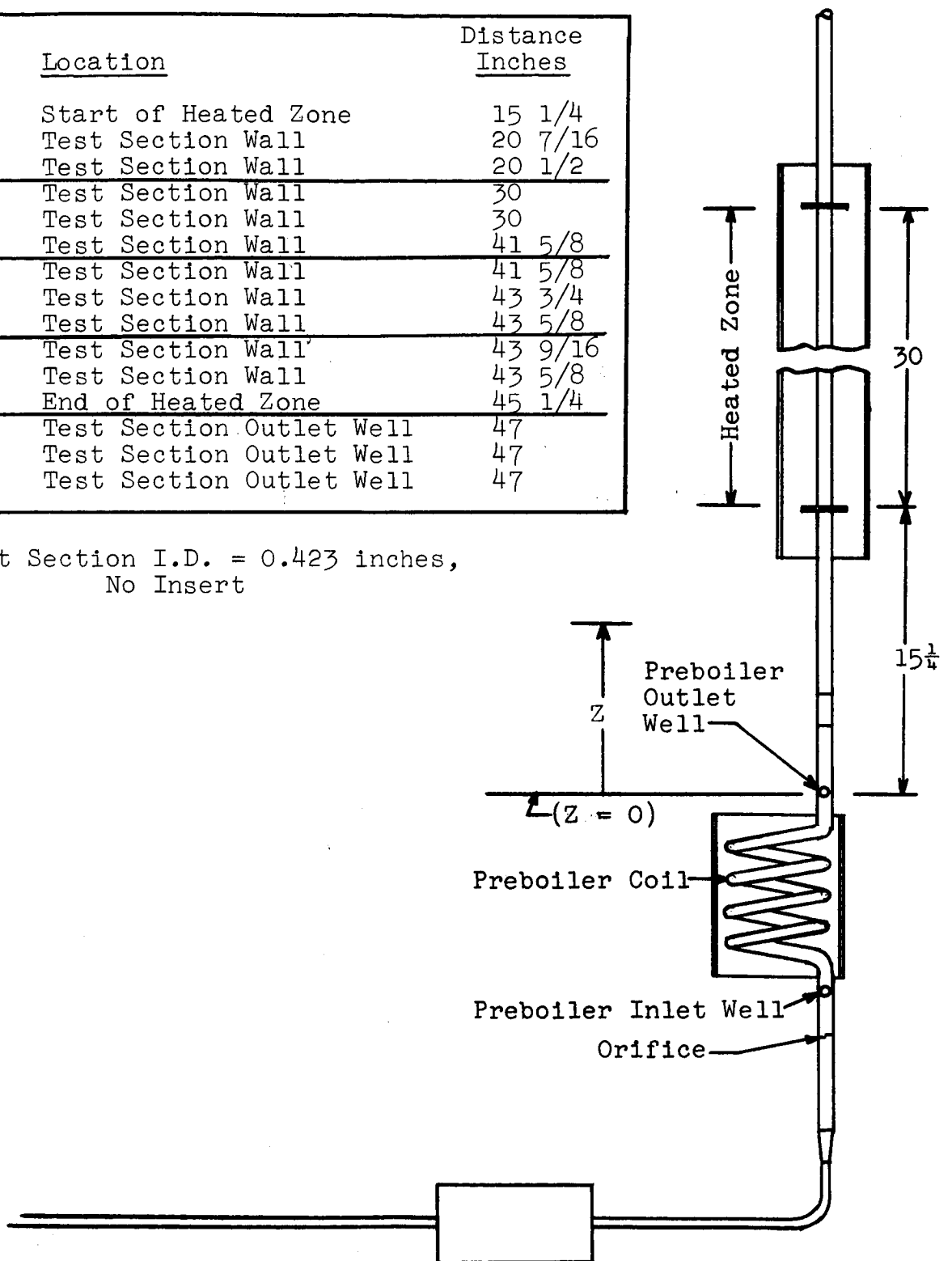
NOMENCLATURE FOR TABULATED 100 KW BOILING DATA

(Key to Tables B-3a through B-3d)

Col. No.	Heading	Description
236	DATE	(e.g., 2.2550 + 03 = 2-25-65)
237	TIME	(e.g., 1.7240 + 03 = 1724)
274	TK FM	Fluid temperature at flowmeter, ^{o}F
282,290	TPB IN	Preboiler inlet temperature, ^{o}F
298-370	PBC N	Preboiler coil temperature, ^{o}F
380,389	TPBOUT	Preboiler outlet well temperature, ^{o}F
443-497	TWO N	Test Section Outside Pipe Wall temperature, ^{o}F
515,524	TTSOUT	Fluid temperature at test section outlet, ^{o}F
540	MAGNET	Flowmeter magnet temperature, ^{o}F
547-617	CND N	Condenser temperature at N, ^{o}F
624-659	PBRADS	Preboiler radiation shield temperature, ^{o}F
666-715	TSRADS	Test Section radiation shield temperature, ^{o}F
774	QN PB	Net preboiler power, KW
780	QN TS	Net test section power, KW
784	Q/A TS	T/S Heat Flux, Btu/hr-ft^2
802	FLOW	Flow rate, lbs/sec
804	G	Mass velocity, lbs/sec-ft^2
807	P SAT	Saturation pressure corresponding to fluid temperature at test section outlet, psi
816	X PB	Preboiler exit quality
823	X TS	Test section exit quality
825	ENTOUT	Mixture Enthalpy at T/S Outlet
828	VELOUT	Vapor velocity, ft/sec
1024-1066	TWI N	Inside wall temperature at N, ^{o}F
1067	DT 31	(TWI 31 - TTSOUT) Avg. at 31, ^{o}F
1068	H 31	$\dfrac{Q/A}{DT\ 31}$, Btu/hr-ft^2 ^{o}F

TABLE B-3a

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	236	237	274	282	290	298
	DATE	TIME	TK FM	TPB IN	TPB IN	PBC 5
1	2.2550+03	1.7240+03	1.0407+03	1.0413+03	1.0418+03	1.8161+03
2	2.2550+03	1.9550+03	1.0622+03	1.0636+03	1.0649+03	1.9194+03
3	2.2550+03	2.1580+03	1.0906+03	1.0783+03	1.0948+03	2.0232+03
4	2.2650+03	5.0000+01	1.1002+03	1.0712+03	1.1051+03	2.1148+03
5	2.2650+03	2.5000+02	1.1321+03	1.1116+03	1.1364+03	2.1996+03
6	2.2650+03	5.0500+02	1.1571+03	1.1475+03	1.1607+03	2.1206+03
7	2.2650+03	8.3000+02	1.2065+03	1.2026+03	1.2068+03	2.1327+03
8	2.2650+03	1.2300+03	1.2166+03	1.2134+03	1.2165+03	2.1336+03
9	2.2650+03	2.0370+03	1.0165+03	1.0143+03	1.0131+03	1.6745+03
10	2.2650+03	2.3070+03	1.0357+03	1.0371+03	1.0363+03	1.8019+03
11	2.2750+03	1.5200+02	1.0390+03	1.0405+03	1.0382+03	1.9212+03
12	2.2750+03	4.3000+02	1.0641+03	1.0670+03	1.0648+03	1.9991+03
13	2.2750+03	6.3200+02	1.0832+03	1.0876+03	1.0860+03	2.0990+03
14	2.2750+03	9.3000+02	1.1163+03	1.1202+03	1.1187+03	2.1770+03
15	2.2750+03	1.2150+03	1.1424+03	1.1456+03	1.1464+03	2.1217+03
16	2.2750+03	1.8380+03	1.0480+03	1.0438+03	1.0433+03	1.6861+03
17	2.2750+03	2.0570+03	1.0588+03	1.0568+03	1.0556+03	1.8058+03
18	2.2750+03	2.3290+03	1.0824+03	1.0816+03	1.0805+03	1.8899+03
19	2.2850+03	2.2300+02	1.1079+03	1.1085+03	1.1084+03	2.0280+03
20	2.2850+03	4.3000+02	1.1318+03	1.1330+03	1.1309+03	2.1206+03
21	2.2850+03	6.2500+02	1.1648+03	1.1647+03	1.1643+03	2.1378+03
22	2.2850+03	9.0000+02	1.1913+03	1.1900+03	1.1894+03	2.1206+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	314	322	330	338	346	362
	PBC 7	PBC 8	PBC 9	PBC 10	PBC 11	PBC 13
1	2.0143+03	2.1001+03	2.1652+03	2.1090+03	2.1140+03	2.0957+03
2	2.1207+03	2.1240+03	2.1144+03	2.1094+03	2.1174+03	2.0996+03
3	2.1166+03	2.1229+03	2.1199+03	2.1147+03	2.1192+03	2.1019+03
4	2.1118+03	2.1228+03	2.1201+03	2.1133+03	2.1189+03	2.0991+03
5	2.1186+03	2.1351+03	2.1231+03	2.1172+03	2.1215+03	2.1020+03
6	2.1247+03	2.1338+03	2.1265+03	2.1211+03	2.1242+03	2.1035+03
7	2.1281+03	2.1353+03	2.1299+03	2.1241+03	2.1271+03	2.1062+03
8	2.1270+03	2.1361+03	2.1311+03	2.1247+03	2.1275+03	2.1050+03
9	1.8723+03	1.9531+03	2.0168+03	2.0704+03	2.1381+03	2.1027+03
10	2.0097+03	2.0928+03	2.1518+03	2.1165+03	2.1172+03	2.0988+03
11	2.1277+03	2.1191+03	2.1090+03	2.1069+03	2.1151+03	2.0964+03
12	2.1158+03	2.1156+03	2.1139+03	2.1118+03	2.1169+03	2.0984+03
13	2.1126+03	2.1236+03	2.1190+03	2.1140+03	2.1204+03	2.1011+03
14	2.1204+03	2.1369+03	2.1260+03	2.1207+03	2.1266+03	2.1075+03
15	2.1209+03	2.1337+03	2.1256+03	2.1198+03	2.1248+03	2.1057+03
16	1.8777+03	1.9545+03	2.0140+03	2.0669+03	2.1340+03	2.0968+03
17	2.0104+03	2.0937+03	2.1519+03	2.1072+03	2.1150+03	2.0963+03
18	2.0943+03	2.1364+03	2.1110+03	2.1069+03	2.1170+03	2.0984+03
19	2.1139+03	2.1212+03	2.1158+03	2.1137+03	2.1210+03	2.1023+03
20	2.1190+03	2.1323+03	2.1260+03	2.1220+03	2.1277+03	2.1070+03
21	2.1211+03	2.1376+03	2.1257+03	2.1204+03	2.1263+03	2.1072+03
22	2.1217+03	2.1345+03	2.1265+03	2.1217+03	2.1267+03	2.1069+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	370	380	389	443	452	497
	PBC 14	TPBOUT	TPBOUT	TWO 22	TWO 23	TWO 31
1	2.1009+03	2.1041+03	2.1190+03	2.1322+03	2.1691+03	2.1299+03
2	2.1045+03	2.1051+03	2.1199+03	2.1367+03	2.1737+03	2.1313+03
3	2.1047+03	2.1047+03	2.1194+03	2.1358+03	2.1729+03	2.1292+03
4	2.1031+03	2.1016+03	2.1165+03	2.1332+03	2.1760+03	2.1279+03
5	2.1060+03	2.1029+03	2.1174+03	2.1336+03	2.1787+03	2.1280+03
6	2.1081+03	2.1034+03	2.1171+03	2.1346+03	2.1770+03	2.1277+03
7	2.1088+03	2.1026+03	2.1169+03	2.1343+03	2.1716+03	2.1268+03
8	2.1076+03	2.1011+03	2.1146+03	2.1310+03	2.1682+03	2.1252+03
9	2.1060+03	2.1324+03	2.1463+03	2.1624+03	2.1973+03	2.1468+03
10	2.1027+03	2.1078+03	2.1226+03	2.1530+03	2.2003+03	2.1489+03
11	2.1013+03	2.1045+03	2.1185+03	2.1494+03	2.1970+03	2.1432+03
12	2.1015+03	2.1034+03	2.1176+03	2.1491+03	2.1991+03	2.1427+03
13	2.1047+03	2.1044+03	2.1191+03	2.1498+03	2.2003+03	2.1428+03
14	2.1106+03	2.1103+03	2.1230+03	2.1543+03	2.2051+03	2.1462+03
15		2.1069+03	2.1194+03	2.1512+03	2.2035+03	2.1437+03
16		2.1301+03	2.1437+03	2.1924+03	2.2558+03	2.1671+03
17		2.1075+03	2.1219+03	2.1842+03	2.2554+03	2.1688+03
18		2.1083+03	2.1219+03	2.1856+03	2.2548+03	2.1682+03
19	2.1052+03	2.1072+03	2.1223+03	2.1793+03	2.2431+03	2.1625+03
20	2.1108+03	2.1133+03	2.1260+03	2.1918+03	2.2612+03	2.1758+03
21	2.1103+03	2.1104+03	2.1238+03	2.1774+03	2.2394+03	2.1626+03
22	2.1096+03	2.1088+03	2.1218+03	2.1752+03	2.2345+03	2.1597+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	515	524	540	547	554	561
	TTSOUT	TTSOUT	MAGNET	CND 37	CND 38	CND 39
1	2.1047+03	2.1067+03	5.8953+02	2.0781+03	1.7806+03	9.2173+02
2	2.1042+03	2.1064+03	6.0621+02	2.0778+03	1.8892+03	9.3898+02
3	2.1022+03	2.1044+03	6.2348+02	2.0751+03	2.0397+03	9.5678+02
4	2.1000+03	2.1019+03	6.3519+02	2.0720+03	2.0383+03	
5	2.1013+03	2.1020+03	6.4999+02	2.0707+03	2.0360+03	
6	2.1007+03	2.1013+03	6.6182+02	2.0700+03	2.0351+03	
7	2.0990+03	2.0994+03	6.7186+02	2.0675+03	2.0316+03	
8	2.0953+03	2.0968+03	6.6749+02	2.0652+03	2.0297+03	
9	2.1079+03	2.1072+03	5.3274+02	2.0822+03	1.7250+03	
10	2.1079+03	2.0836+03	5.5399+02	2.0822+03	1.8230+03	
11	2.1049+03	2.1048+03	5.6387+02	2.0779+03	1.9686+03	
12	2.1036+03	2.1037+03	5.7589+02	2.0752+03	2.0383+03	
13	2.1031+03	2.1040+03	5.8965+02	2.0748+03	2.0407+03	
14	2.1051+03	2.1070+03	6.0529+02	2.0780+03	2.0422+03	
15	2.1009+03	2.1023+03	6.1844+02	2.0734+03	2.0378+03	
16	2.1035+03	2.1047+03	5.5065+02	2.0766+03	2.0028+03	
17	2.1053+03	2.1066+03	5.5810+02	2.0781+03	2.0458+03	
18	2.1061+03	2.1068+03	5.7052+02	2.0774+03	2.0444+03	
19	2.1049+03	2.1056+03	5.8798+02	2.0754+03	2.0415+03	
20	2.1174+03	2.1124+03	6.0031+02	2.0779+03	2.0441+03	
21	2.1028+03	2.1043+03	6.1507+02	2.0752+03	2.0401+03	
22	2.1016+03	2.1028+03	6.2639+02	2.0733+03	2.0381+03	

1CO KW BOILING DATA .423-IN. TUBE, NO INSERT

	568	575	582	589	596	6C3
	CND 40	CND 41	CND 42	CND 43	CND 44	CND 45
1	1.1965+C3	1.3009+03		1.2240+03	1.0600+03	1.1641+03
2	1.2327+C3	1.3341+03		1.2533+03	1.0865+03	1.1897+03
3	1.2886+C3	1.3845+03		1.2948+03	1.1183+03	1.2249+03
4		1.4295+03		1.3293+03		1.2528+03
5		1.4939+C3		1.3802+C3		1.2944+03
6		1.5703+C3		1.4363+C3		1.3375+03
7	1.5676+C3	1.6835+03	1.5980+03	1.5200+03	1.2855+03	1.4C36+03
8	1.7139+C3	1.7996+C3	1.6794+03	1.5809+03		1.4481+03
9	1.1998+03	1.2960+03	1.2501+03	1.2075+03		1.1420+03
10	1.2332+03	1.3278+03	1.2790+03	1.2344+C3		1.165C+03
11		1.3554+03	1.3041+03	1.2557+03		1.1810+03
12		1.4067+03	1.3500+03	1.2972+03		1.2157+C3
13		1.4608+03	1.3972+03	1.3385+03		1.2499+03
14	1.4381+C3	1.5345+03	1.4634+03	1.3977+C3		1.2988+03
15	1.5159+C3	1.6131+03	1.5276+03	1.4524+C3		1.3404+03
16	1.2735+03	1.3713+03	1.3165+03	1.2659+03		1.1891+03
17	1.3156+03	1.4134+03	1.3537+03	1.2993+03		1.2162+03
18	1.3702+C3	1.4704+C3	1.4044+03	1.3447+03		1.2539+03
19		1.5402+03	1.4648+03	1.3955+03		1.2931+03
20		1.6142+03	1.5240+03	1.4473+03		1.3343+03
21		1.7276+03	1.6174+03	1.5247+03	1.2631+03	1.3918+03
22	1.7356+C3	1.8054+03	1.6848+03	1.5805+03	1.3056+03	1.4345+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	610 CND 46	617 CND 47	624 PBRADS	631 PBRADS	638 PBRADS	645 PBRADS
1	1.1360+03	1.1145+03	9.2856+02	9.6455+02	8.9677+02	9.0768+02
2	1.1599+03	1.1370+03	9.6110+02	9.9403+02	9.2915+02	9.4100+02
3	1.1919+03	1.1671+03	9.9571+02	1.0265+03	9.6370+02	9.7514+02
4	1.2169+03	1.1889+03	1.0234+03	1.0519+03	9.9120+02	1.0015+03
5	1.2553+03	1.2248+03	1.0524+03	1.0780+03	1.0199+03	1.0287+03
6	1.2934+03	1.2592+03	1.0767+03	1.1005+03	1.0457+03	1.0528+03
7	1.3519+03	1.3124+03	1.1000+03	1.1213+03	1.0957+03	1.0982+03
8	1.3894+03	1.3448+03	1.1115+03	1.1301+03	1.0843+03	1.0864+03
9	1.1117+03	1.0880+03	8.5522+02	8.9551+02	8.2711+02	8.3164+02
10	1.1326+03	1.1081+03	8.9650+02	9.3341+02	8.6446+02	8.7540+02
11	1.1469+03	1.1207+03	9.2944+02	9.6251+02	8.9568+02	9.0987+02
12	1.1782+03	1.1501+03	9.5918+02	9.8932+02	9.2683+02	9.4083+02
13	1.2089+03	1.1773+03	9.9080+02	1.0185+03	9.5985+02	9.7266+02
14	1.2536+03	1.2188+03	1.0234+03	1.0485+03	9.9317+02	1.0034+03
15	1.2903+03	1.2521+03	1.0468+03	1.0694+03	1.0175+03	1.0260+03
16	1.1533+03	1.1267+03	8.6344+02	9.0247+02	8.3692+02	8.3433+02
17	1.1785+03	1.1494+03	9.0599+02	9.4133+02	8.7611+02	8.7932+02
18	1.2118+03	1.1797+03	9.3421+02	9.6665+02	9.0453+02	9.0851+02
19	1.2470+03	1.2118+03	9.7286+02	1.0014+03	9.4300+02	9.4891+02
20	1.2844+03	1.2459+03	1.0019+03	1.0284+03	9.7257+02	9.7744+02
21	1.3352+03	1.2913+03	1.0315+03	1.0550+03	1.0023+03	1.0046+03
22	1.3728+03	1.3260+03	1.0510+03	1.0727+03	1.0213+03	1.0219+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	652	659	666	673	680	687
	PBRADS	PBRADS	TSRADS	TSRADS	TSRADS	TSRADS
1	8.8772+02	9.5677+02	1.1517+03	1.1523+03	1.1716+03	1.1710+03
2	9.2077+02	9.8708+02	1.1581+03	1.1588+03	1.1787+03	1.1790+03
3	9.5436+02	1.0188+03	1.1620+03	1.1627+03	1.1835+03	1.1836+03
4	9.8063+02	1.0435+03	1.1732+03	1.1739+03	1.1934+03	1.1941+03
5	1.0077+03	1.0685+03	1.1762+03	1.1770+03	1.1966+03	1.1975+03
6	1.0326+03	1.0896+03	1.1752+03	1.1760+03	1.1973+03	1.1979+03
7	1.0743+03	1.1243+03	1.1845+03	1.1835+03	1.2001+03	1.1990+03
8	1.0688+03	1.1173+03	1.1752+03	1.1760+03	1.1976+03	1.1988+03
9	8.1730+02	8.8330+02	1.2097+03	1.2102+03	1.2333+03	1.2325+03
10	8.5861+02	9.2528+02	1.2112+03	1.2118+03	1.2345+03	1.2347+03
11	8.9159+02	9.5657+02	1.2151+03	1.2157+03	1.2394+03	1.2403+03
12	9.2294+02	9.8462+02	1.2150+03	1.2156+03	1.2388+03	1.2395+03
13	9.5583+02	1.0141+03	1.2205+03	1.2212+03	1.2441+03	1.2454+03
14	9.8787+02	1.0443+03	1.2306+03	1.2313+03	1.2550+03	1.2572+03
15	1.0110+03	1.0653+03	1.2351+03	1.2359+03	1.2594+03	1.2604+03
16	8.2250+02	8.8657+02	1.2762+03	1.2767+03	1.2998+03	1.3010+03
17	8.6538+02	9.2919+02	1.2915+03	1.2920+03	1.3013+03	1.3033+03
18	8.9216+02	9.5562+02	1.2900+03	1.2906+03	1.3014+03	1.3039+03
19	9.3389+02	9.9216+02	1.2782+03	1.2788+03	1.2888+03	1.2921+03
20	9.6273+02	1.0191+03	1.2760+03	1.2766+03	1.2868+03	1.2900+03
21	9.9083+02	1.0453+03	1.2775+03	1.2782+03	1.2880+03	1.2921+03
22	1.0087+03	1.0615+03	1.2724+03	1.2731+03	1.2830+03	1.2875+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	708	715	774	780	784	802
	TSRADS	TSRADS	QN PB	QN TS	Q/A TS	FLCW
1	1.1886+03	1.0813+03	1.5585+01	8.1248+00	1.0002+05	6.0212-02
2	1.1965+03	1.0888+03	1.7596+01	7.8935+00	9.7175+04	6.0756-02
3	1.2000+03	1.0892+03	2.0168+01	7.7631+00	9.5571+04	6.0961-02
4	1.2096+03	1.0966+03	2.2773+01	7.7167+00	9.5000+04	5.9569-02
5	1.2126+03	1.1003+03	2.5326+01	7.9532+00	9.7911+04	5.9772-02
6	1.2121+03	1.0994+03	2.8444+01	8.0502+00	9.9105+04	5.9914-02
7	1.2115+03	1.0971+03	3.0826+01	8.2008+00	1.0096+05	6.1605-02
8	1.2126+03	1.0961+03	3.3267+01	8.4140+00	1.0358+05	6.1597-02
9	1.2523+03	1.1112+03	1.3401+01	1.1662+01	1.4357+05	6.0200-02
10	1.2517+03	1.1128+03	1.5425+01	1.1486+01	1.4141+05	5.9980-02
11	1.2575+03	1.1188+03	1.7593+01	1.1984+01	1.4753+05	5.8626-02
12	1.2558+03	1.1188+03	1.9687+01	1.1995+01	1.4767+05	5.9571-02
13	1.2612+03	1.1240+03	2.2295+01	1.2032+01	1.4812+05	5.9027-02
14	1.2720+03	1.1359+03	2.4060+01	1.2406+01	1.5273+05	6.0026-02
15	1.2765+03	1.1409+03	2.7539+01	1.2567+01	1.5471+05	6.0204-02
16	1.3136+03	1.1703+03	1.2549+01	1.7521+01	2.1569+05	5.9342-02
17	1.3153+03	1.1710+03	1.5083+01	1.7892+01	2.2027+05	5.9307-02
18	1.3168+03	1.1728+03	1.7074+01	1.8889+01	2.3254+05	6.0555-02
19	1.3093+03	1.1673+03	1.9837+01	1.8102+01	2.2286+05	5.9021-02
20	1.3065+03	1.1666+03	2.2397+01	1.8144+01	2.2337+05	5.8929-02
21	1.3084+03	1.1704+03	2.4932+01	1.8104+01	2.2287+05	5.8664-02
22	1.3039+03	1.1668+03	2.6815+01	1.8201+01	2.2407+05	6.0332-02

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	804	807	816	823	825	828
	G	P SAT	X PB	X TS	ENTOUT	VELOUT
1	6.1567+01	2.0380+02	3.4004-02	2.1357-01	6.6312+02	3.7448+01
2	6.2123+01	2.0358+02	8.0295-02	2.5355-01	6.9180+02	4.4907+01
3	6.2332+01	2.0249+02	1.4065-01	3.1075-01	7.3261+02	5.5502+01
4	6.0909+01	2.0122+02	2.0978-01	3.8238-01	7.8380+02	6.7130+01
5	6.1116+01	2.0160+02	2.7367-01	4.5091-01	8.3324+02	7.9290+01
6	6.1262+01	2.0123+02	3.4908-01	5.2803-01	8.8867+02	9.3231+01
7	6.2991+01	2.0030+02	3.9668-01	5.7408-01	9.2162+02	1.0467+02
8	6.2982+01	1.9863+02	4.5226-01	6.3421-01	9.6459+02	1.1649+02
9	6.1554+01	2.0482+02	-2.9792-02	2.3556-01	6.7927+02	4.1103+01
10	6.1329+01	1.9849+02	2.9463-02	2.8701-01	7.1425+02	5.1364+01
11	5.9945+01	2.0332+02	8.7911-02	3.5912-01	7.6767+02	6.1448+01
12	6.0911+01	2.0267+02	1.3522-01	4.0233-01	7.9857+02	7.0160+01
13	6.0355+01	2.0263+02	2.0265-01	4.7325-01	8.4959+02	8.1789+01
14	6.1376+01	2.0400+02	2.4062-01	5.1566-01	8.8045+02	9.0056+01
15	6.1558+01	2.0155+02	3.2339-01	6.0087-01	9.4119+02	1.0645+02
16	6.0677+01	2.0294+02	-3.5961-02	3.6327-01	7.7054+02	6.3029+01
17	6.0641+01	2.0393+02	3.0960-02	4.3116-01	8.1965+02	7.4420+01
18	6.1917+01	2.0420+02	7.3819-02	4.8745-01	8.6021+02	8.5800+01
19	6.0349+01	2.0354+02	1.5268-01	5.5939-01	9.1179+02	9.6263+01
20	6.0254+01	2.0878+02	2.1581-01	6.2367+01	9.5914+02	1.0463+02
21	5.9984+01	2.0262+02	2.8462-01	6.9433-01	1.0087+03	1.1927+02
22	6.1689+01	2.0189+02	3.1755-01	7.1781-01	1.0255+03	1.2724+02

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	1024	1031	1066	1067	1068
	TWI 22	TWI 23	TWI 31	DT 31	H 31
1	2.1083+03	2.1453+03	2.1060+03	2.7899-01	3.5852+05
2	2.1135+03	2.1506+03	2.1081+03	2.7557+00	3.5264+04
3	2.1130+03	2.1502+03	2.1064+03	3.0928+00	3.0901+04
4	2.1105+03	2.1534+03	2.1052+03	4.2318+00	2.2449+04
5	2.1102+03	2.1554+03	2.1047+03	3.0129+00	3.2497+04
6	2.1110+03	2.1534+03	2.1041+03	3.1023+00	3.1946+04
7	2.1102+03	2.1476+03	2.1027+03	3.5066+00	2.8791+04
8	2.1063+03	2.1435+03	2.1005+03	4.4529+00	2.3262+04
9	2.1282+03	2.1632+03	2.1126+03	5.0034+00	2.8696+04
10	2.1193+03	2.1667+03	2.1152+03	1.9439+01	7.2744+03
11	2.1142+03	2.1619+03	2.1080+03	3.1903+00	4.6243+04
12	2.1139+03	2.1640+03	2.1075+03	3.8472+00	3.8384+04
13	2.1145+03	2.1650+03	2.1075+03	3.9099+00	3.7883+04
14	2.1178+03	2.1688+03	2.1098+03	3.6949+00	4.1337+04
15	2.1143+03	2.1667+03	2.1068+03	5.2168+00	2.9656+04
16	2.1411+03	2.2047+03	2.1158+03	1.1657+01	1.8504+04
17	2.1318+03	2.2033+03	2.1163+03	1.0382+01	2.1217+04
18	2.1303+03	2.1997+03	2.1129+03	6.4061+00	3.6300+04
19	2.1263+03	2.1903+03	2.1094+03	4.1394+00	5.3838+04
20	2.1386+03	2.2083+03	2.1226+03	7.7097+00	2.8973+04
21	2.1244+03	2.1866+03	2.1095+03	6.0039+00	3.7121+04
22	2.1219+03	2.1814+03	2.1063+03	4.1487+00	5.4009+04

TABLE B-3b

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	236	237	274	282	290	298
	DATE	TIME	TK FM	TPB IN	TPB IN	PBC 5
1	3.1250+03	1.4300+03	9.0676+02	8.9879+02	8.9885+02	1.6956+03
2	3.1250+03	1.6250+03	9.1789+02	9.1341+02	9.1264+02	1.8873+03
3	3.1250+03	1.9320+03	9.3387+02	9.3042+02	9.2865+02	2.0174+03
4	3.1250+03	2.2040+03	9.6197+02	9.5784+02	9.5624+02	2.1074+03
5	3.1350+03	2.1700+02	9.6313+02	9.6086+02	9.5820+02	
6	3.1650+03	1.3300+03	9.4296+02	9.3352+02	9.3365+02	1.7908+03
7	3.1650+03	1.6160+03	9.4690+02	9.3656+02	9.3689+02	1.7798+03
8	3.1850+03	4.3000+02	8.7249+02	8.4981+02	8.5763+02	
9	3.1850+03	6.5000+02	8.7747+02	8.5805+02	8.6417+02	
10	3.1850+03	1.0300+03	8.8421+02	8.6717+02	8.7221+02	

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	306	314	322	330	338	346
	PBC 6	PBC 7	PBC 8	PBC 9	PBC 10	PBC 11
1	1.8057+03	1.8738+03	1.9280+03	1.9946+03	2.0220+03	2.0628+03
2	2.0058+03	2.0750+03	2.1274+03	2.1212+03	2.1027+03	2.1080+03
3	2.1363+03	2.1248+03	2.1058+03	2.1151+03	2.1061+03	2.1071+03
4	2.1362+03	2.1213+03	2.1143+03	2.1178+03	2.1109+03	2.1099+03
5	2.1414+03	2.1314+03	2.1274+03	2.1248+03	2.1218+03	2.1164+03
6	1.8305+03	1.8927+03	1.9411+03	2.0079+03	2.0315+03	2.0677+03
7	1.8191+03	1.8808+03	1.9298+03	1.9961+03	2.0194+03	2.0565+03
8	8.5745+02	8.5485+02	8.4549+02	8.5138+02	8.4356+02	8.4252+02
9	1.0165+03	1.0305+03	1.0394+03	1.0663+03	1.0737+03	1.0951+03
10	1.1570+03	1.1865+03	1.2100+03	1.2530+03	1.2714+03	1.3084+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	362	370	380	389	425	434
	PBC 13	PBC 14	TPBOUT	TPBOUT	TWO 20	TWO 21
1	2.0379+03	2.0466+03	2.0548+03	2.0609+03		2.1445+03
2	2.0905+03	2.0981+03	2.1041+03	2.1088+03		2.1376+03
3	2.0889+03	2.0971+03	2.1023+03	2.1064+03		2.1336+03
4	2.0917+03	2.0991+03	2.1042+03	2.1072+03		2.1338+03
5	2.1003+03	2.1039+03	2.1080+03	2.1105+03		2.1377+03
6	2.0459+03	2.0531+03	2.0615+03	2.0626+03		2.1704+03
7	2.0270+03	2.0421+03	2.0512+03	2.0524+03		2.1246+03
8	8.4082+02	8.4044+02	8.5145+02	8.4210+02		1.3006+03
9	1.0875+03	1.0896+03	1.0912+03	1.0948+03		1.5605+03
10	1.2944+03	1.3007+03	1.2988+03	1.3081+03		1.7740+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	470 TWO 25	488 TWC 27	497 TWO 31	506 TWO 32	515 TTSOUT	524 TTSOUT
1	2.1269+03	2.1319+03	2.1346+03	2.1351+03	2.1057+03	2.1048+03
2	2.1293+03	2.1353+03	2.1362+03	2.1369+03	2.1056+03	2.1049+03
3	2.1260+03	2.1340+03	2.1324+03	2.1333+03	2.1035+03	2.1032+03
4	2.1295+03	2.1324+03	2.1346+03	2.1362+03	2.1041+03	2.1043+03
5	2.1343+03	2.1384+03	2.1407+03	2.1394+03	2.1070+03	2.1070+03
6	2.1656+03	2.1625+03	2.1576+03	2.1643+03	2.1120+03	2.1133+03
7	2.1155+03	2.1140+03	2.1098+03	2.1113+03	2.0695+03	2.0603+03
8	2.1607+03	2.1588+03	2.1558+03	2.1595+03	2.1044+03	2.1061+03
9	2.1119+03	2.1479+03	2.1445+03	2.1477+03	2.0957+03	2.0974+03
10	2.1651+03	2.1534+03	2.1490+03	2.1533+03	2.1021+03	2.1026+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	540 MAGNET	547 CND 37	561 CND 39	568 CND 40	575 CND 41	582 CND 42
1	4.5562+02	2.0806+03	1.1214+03	9.4253+02	9.9731+02	9.6342+02
2	4.7162+02	2.0895+03	1.0894+03	9.7657+02	1.0306+03	1.0029+03
3	4.8874+02	2.0786+03	1.1993+03	1.0001+03	1.0557+03	1.0167+03
4	5.0253+02	2.0787+03	1.2433+03	1.0290+03	1.0845+03	1.0449+03
5	5.1667+02	2.0898+03	1.2963+03	1.0641+03	1.1162+03	1.0738+03
6	4.7767+02	2.0913+03	7.9086+02	9.9752+02	1.0541+03	1.0147+03
7	4.7979+02	2.0392+03		1.0051+03	1.0626+03	1.0220+03
8	3.9634+02	2.0668+03	1.0641+03		9.4510+02	9.1243+02
9	4.0225+02	2.0781+03	1.0998+03		9.6196+02	9.2847+02
10	4.1840+02	2.0791+03	1.1142+03	9.1192+02	9.7834+02	9.4433+02

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	589	596	603	610	617	624
	CND 43	CND 44	CND 45	CND 46	CND 47	PBRADS
1	9.3262+02	8.8847+02	8.8231+02	8.5841+02	8.3944+02	7.5246+02
2	9.7055+02	9.2573+02	9.1626+02	8.9019+02	8.7017+02	8.1533+02
3	9.8213+02	9.3775+02	9.2860+02	9.0267+02	8.8220+02	8.4939+02
4	1.0082+03	9.6121+02	9.5067+02	9.2379+02	9.0298+02	8.7718+02
5	1.0337+03	9.8300+02	9.7238+02	9.4435+02	9.2210+02	9.0664+02
6	9.8004+02	9.3248+02	9.2558+02	8.9920+02	8.7632+02	7.6333+02
7	9.8588+02	9.3723+02	9.2996+02	9.0310+02	8.8228+02	7.6120+02
8	8.8218+02	8.3518+02	8.3325+02	8.0932+02	7.9072+02	4.5571+02
9	8.9737+02	8.5034+02	8.4719+02	8.2274+02	8.0372+02	5.1317+02
10	9.1316+02	8.6616+02	8.6244+02	8.3768+02	8.1846+02	5.6338+02

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	631	638	645	652	659	666
	PBRADS	PBRADS	PBRADS	PBRADS	PBRADS	TSRADS
1	7.8756+02	7.2399+02	7.4641+02	7.4096+02	7.8837+02	1.0697+03
2	8.4781+02	7.8334+02	8.1127+02	8.0061+02	8.5029+02	1.0760+03
3	8.7810+02	8.1714+02	8.4511+02	8.3441+02	8.8085+02	1.0782+03
4	9.0360+02	8.4275+02	8.7211+02	8.6123+02	9.0577+02	1.0838+03
5	9.3105+02	8.7211+02	9.0052+02	8.8846+02	9.3211+02	1.0969+03
6	8.0011+02	7.3274+02	7.5039+02	7.4135+02	7.9865+02	1.1885+03
7	7.9809+02	7.3087+02	7.4723+02	7.3922+02	7.9516+02	1.1908+03
8	4.7391+02	4.4690+02	3.9881+02	3.9647+02	4.4058+02	1.1302+03
9	5.4203+02	5.0414+02	4.6688+02	4.7078+02	5.1291+02	1.1465+03
10	5.9593+02	5.5213+02	5.2834+02	5.3349+02	5.7250+02	1.1505+03

	673	680	687	708	715	774
	TSRADS	TSRADS	TSRADS	TSRADS	TSRADS	QN PB
1	1.0651+03	1.0711+03	1.0665+03	1.0918+03	1.1066+03	7.5714+00
2	1.0729+03	1.0775+03	1.0743+03	1.0991+03	1.1151+03	9.5645+00
3	1.0775+03	1.0798+03	1.0791+03	1.1015+03	1.1183+03	1.1330+01
4	1.0843+03	1.0856+03	1.0860+03	1.1077+03	1.1251+03	1.3003+01
5	1.0990+03	1.0987+03	1.1008+03	1.1199+03	1.1379+03	1.4765+01
6	1.1960+03	1.1901+03	1.1976+03	1.2044+03	1.2297+03	7.4118+00
7	1.1994+03	1.1924+03	1.2010+03	1.2078+03	1.2339+03	7.4391+00
8	1.1294+03	1.1311+03	1.1302+03	1.1274+03	1.1461+03	-5.3292-01
9	1.1464+03	1.1474+03	1.1473+03	1.1407+03	1.1596+03	1.1570+00
10	1.1511+03	1.1514+03	1.1520+03	1.1440+03	1.1622+03	2.4412+00

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	780	784	802	804	807	816
	QN TS	Q/A TS	FLOW	G	P SAT	X PB
1	7.8582+00	9.6741+04	3.0655-02	3.1345+01	2.0354+02	-1.8965-03
2	8.0259+00	9.8805+04	3.0793-02	3.1486+01	2.0355+02	7.0953-02
3	7.6673+00	9.4391+04	3.0645-02	3.1334+01	2.0250+02	1.5361-01
4	7.7034+00	9.4836+04	3.1045-02	3.1743+01	2.0300+02	2.2491-01
5	8.1473+00	1.0030+05	3.0428-02	3.1113+01	2.0450+02	3.1222-01
6	1.2144+01	1.4951+05	3.1125-02	3.1826+01	2.0755+02	-6.0090-03
7	1.2479+01	1.5363+05	3.1289-02	3.1993+01	1.8263+02	-2.6860-03
8	1.2275+01	1.5112+05	3.0357-02	3.1040+01	2.0356+02	-1.7067-02
9	1.2087+01	1.4980+05	3.0418-02	3.1102+01	1.9892+02	-7.2699-03
10	1.2012+01	1.4788+05	3.0867-02	3.1561+01	2.0198+02	-8.5266-03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	823	825	828	1017	1045	1059
	X TS	ENTOUT	VELOUT	TWI 21	TWI 25	TWI 27
1	3.2167-01	7.4079+02	2.8750+01	2.1215+03	2.1038+03	2.1088+03
2	4.1474-01	8.0774+02	3.7234+01	2.1140+03	2.1057+03	2.1117+03
3	4.8343-01	8.5688+02	4.3401+01	2.1110+03	2.1034+03	2.1115+03
4	5.5217-01	9.0647+02	5.0103+01	2.1111+03	2.1069+03	2.1098+03
5	6.6570-01	9.8846+02	5.8800+01	2.1138+03	2.1104+03	2.1145+03
6	4.9371-01	8.6556+02	4.3989+01	2.1348+03	2.1299+03	2.1269+03
7	5.1409-01	8.7398+02	5.1761+01	2.0879+03	2.0787+03	2.0773+03
8	1.5711-01	6.2242+02	1.3904+01	1.2625+03	2.1247+03	2.1227+03
9	2.2513-01	6.6979+02	2.0393+01	1.5236+03	2.0763+03	2.1124+03
10	2.6904-01	7.0243+02	2.4388+01	1.7379+03	2.1299+03	2.1182+03

ENTOUT ——— VELOUT ——— TWI 21 ——— TWI 25 ——— TWI 27

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	1060	1061	1066	1067	1068	1073
	DT 27	H 27	TWI 31	DT 31	H 31	TWI 32
1	3.5739+00	2.7068+04	2.1116+03	6.3152+00	1.5319+04	2.1120+03
2	6.4211+00	1.5387+04	2.1126+03	7.3933+00	1.3364+04	2.1133+03
3	8.1380+00	1.1599+04	2.1099+03	6.5805+00	1.4344+04	2.1107+03
4	5.5382+00	1.7124+04	2.1120+03	7.7272+00	1.2273+04	2.1136+03
5	7.4520+00	1.3459+04	2.1167+03	9.7441+00	1.0293+04	2.1154+03
6	1.4245+01	1.0496+04	2.1219+03	9.2861+00	1.6100+04	2.1287+03
7	1.2413+01	1.2376+04	2.0731+03	8.1652+00	1.8815+04	2.0746+03
8	1.7473+01	8.6485+03	2.1198+03	1.4550+01	1.0386+04	2.1235+03
9	1.5832+01	9.3986+03	2.1090+03	1.2465+01	1.1938+04	2.1123+03
10	1.5802+01	9.3585+03	2.1138+03	1.1391+01	1.2982+04	2.1180+03

100 KW BCILING DATA .423-IN. TUBE, NO INSERT

	1074	1075
	DT 32	H 32
1	6.8064+00	1.4213+04
2	8.0741+00	1.2237+04
3	7.4044+00	1.2748+04
4	9.3569+00	1.0135+04
5	8.4218+00	1.1910+04
6	1.6066+01	9.3057+03
7	9.6809+00	1.5869+04
8	1.8259+01	8.2762+03
9	1.5678+01	9.4911+03
10	1.5670+01	9.4376+03

TABLE B-3c
100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	236	237	274	282	290	306
	DATE	TIME	TK FM	TPB IN	TPB IN	PBC 6
1	3.2550+03	7.3000+02	9.0010+02	8.9413+02	8.9329+02	1.8854+03
2	3.2550+03	1.3300+03	9.3945+02	1.1903+03	1.1932+03	1.8788+03
3	3.2650+03	3.0800+02	9.8670+02	9.8049+02	9.8097+02	1.8504+03
4	3.2650+03	3.5000+02	1.0021+03	9.9303+02	9.9455+02	1.8493+03
5	3.2650+03	4.3000+02	1.0104+03	1.0044+03	1.0041+03	1.8540+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	314	322	330	338	346	362
	PBC 7	PBC 8	PBC 9	PBC 10	PBC 11	PBC 13
1	1.8205+03	1.8095+03	1.8198+03	1.8075+03	1.8122+03	1.8001+03
2	1.8726+03	1.8596+03	1.8722+03	1.8602+03	1.8645+03	1.8511+03
3	1.8460+03	1.8484+03	1.8374+03	1.8300+03	1.8416+03	1.8138+03
4	1.8376+03	1.8428+03	1.8366+03	1.8255+03	1.8303+03	1.8203+03
5	1.8405+03	1.8369+03	1.8352+03	1.8274+03	1.8308+03	1.8157+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	370	380	389	443	461	470
	PBC 14	TPBOUT	TPBOUT	TWO 22	TWO 24	TWO 25
1	1.8026+03	1.8145+03	1.8086+03	1.8336+03	1.8318+03	1.8368+03
2	1.8546+03	1.8681+03	1.8623+03	1.8913+03	1.8904+03	1.8940+03
3	1.8099+03	1.8178+03	1.8147+03	1.8395+03	1.8375+03	1.8395+03
4	1.8128+03	1.8210+03	1.8163+03	1.8376+03	1.8369+03	1.8370+03
5	1.8141+03	1.8207+03	1.8173+03	1.8383+03	1.8373+03	1.8374+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	488	497	515	524	540	547
	TWO 27	TWO 31	TTSOUT	TTSOUT	MAGNET	CND 37
1	1.8313+03	1.8311+03	1.8044+03	1.8048+03	4.6135+02	1.7868+03
2	1.8886+03	1.8892+03	1.8622+03	1.8621+03	4.8519+02	1.8425+03
3	1.8339+03	1.8351+03	1.8066+03	1.8041+03	4.9294+02	1.7886+03
4	1.8321+03	1.8321+03	1.8041+03	1.8055+03	5.0733+02	1.7874+03
5	1.8352+03	1.8336+03	1.8057+03	1.8120+03	5.1138+02	1.7879+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	554	561	568	575	582	589
	CND 38	CND 39	CND 40	CND 41	CND 42	CND 43
1	1.8569+03	9.4684+02	9.8953+02	1.0585+03	1.0142+03	9.7561+02
2		6.3171+02	9.9109+02	1.0539+03	1.0120+03	9.7595+02
3	1.7913+03	1.7221+03	1.1999+03	1.2474+03	1.1598+03	1.1121+03
4	1.8051+03	1.8040+03		1.2522+03	1.1784+03	1.1200+03
5	1.8047+03	1.7191+03	1.2975+03	1.3518+03	1.2634+03	1.1938+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	596	603	610	617	624	631
	CND 44	CND 45	CND 46	CND 47	PBRADS	PBRADS
1	9.1806+02	9.1588+02	8.8743+02	8.6519+02	7.6053+02	7.9091+02
2	9.2018+02	9.1826+02	8.9081+02	8.6943+02	7.7769+02	8.0485+02
3	1.0326+03	1.0240+03	9.8553+02	9.5617+02	8.5494+02	8.8230+02
4	1.0413+03	1.0327+03	9.9335+02	9.6390+02	8.5504+02	8.8112+02
5	1.1051+03	1.0878+03	1.0376+03	9.8281+02	8.7545+02	9.0084+02

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	638	645	652	659	666	673
	PBRADS	PBRADS	PBRADS	PBRADS	TSRADS	TSRADS
1	7.3620+02	7.5007+02	7.4455+02	7.8755+02	1.0165+03	1.0183+03
2	7.5680+02	7.7214+02	7.7544+02	8.0425+02	1.0236+03	1.0256+03
3	8.4110+02	8.4567+02	8.5332+02	8.7450+02	1.0154+03	1.0158+03
4	8.4078+02	8.4402+02	8.5191+02	8.7302+02	1.0284+03	1.0321+03
5	8.6129+02	8.6308+02	8.7184+02	8.9010+02	1.0337+03	1.0341+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	680	687	708	715	774	780
	TSRADS	TSRADS	TSRADS	TSRADS	QN PB	QN TS
1	1.0180+03	1.0198+03	1.0238+03	1.0464+03	9.4861+00	8.0657+00
2	1.0257+03	1.0277+03	1.0304+03	1.0525+03	8.5455+00	7.9458+00
3	1.0373+03	1.0377+03	1.0405+03	1.0662+03	1.5666+01	8.0156+00
4	1.0301+03	1.0339+03	1.0371+03	1.0641+03	1.5583+01	7.9820+00
5	1.0355+03	1.0359+03	1.0427+03	1.0702+03	1.7471+01	7.9073+00

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

784	802	804	807	816	823
Q/A TS	FLOW	G	P SAT	X PB	X TS

1	9.9295+04	2.9834-02	3.0505+01	8.2553+01	1.5275-01	4.8721-01
2	9.7820+04	3.0609-02	3.1297+01	9.9973+01	1.6468-01	4.8910-01
3	9.8678+04	2.9169-02	2.9825+01	8.2776+01	4.4252-01	7.8277-01
4	9.8265+04	2.9873-02	3.0545+01	8.2615+01	4.2614-01	7.5756-01
5	9.7346+04	3.1689-02	3.2402+01	8.3777+01	4.6526-01	7.7445-01

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	825	828	1024	1038	1045	1059
	ENTOUT	VELOUT	TWI 22	TWI 24	TWI 25	TWI 27
1	8.2046+02	9.7235+01	1.8094+03	1.8076+03	1.8127+03	1.8071+03
2	8.2930+02	8.3863+01	1.8675+03	1.8667+03	1.8703+03	1.8649+03
3	1.0481+03	1.5235+02	1.8155+03	1.8135+03	1.8154+03	1.8099+03
4	1.0287+03	1.5129+02	1.8137+03	1.8130+03	1.8131+03	1.8081+03
5	1.0420+03	1.6189+02	1.8146+03	1.8136+03	1.8137+03	1.8115+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	1060	1061	1066	1067	1068
	DT 27	H 27	TWI 31	DT 31	H 31
1	2.5481+00	3.8968+04	1.3069+03	2.3644+00	4.1995+04
2	2.7111+00	3.6081+04	1.8654+03	3.2824+00	2.9801+04
3	4.5633+00	2.1625+04	1.8111+03	5.7153+00	1.7266+04
4	3.3482+00	2.9349+04	1.8082+03	3.4279+00	2.8666+04
5	2.6808+00	3.6313+04	1.8099+03	1.0253+00	9.4941+04

TABLE B-3d

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	236	237	274	282	290	298
	DATE	TIME	TK FM	TPB IN	TPB IN	PBC 5
1	3.3050+03	1.9410+03	1.2737+03	1.2504+03	1.2568+03	2.0804+03
2	3.3050+03	2.2000+03	1.2968+03	1.2736+03	1.2799+03	2.1915+03
3	3.3150+03	1.4000+02	1.3171+03	1.2940+03	1.2992+03	2.3121+03
4	3.3150+03	3.3000+02	1.3466+03	1.3225+03	1.3275+03	2.4045+03
5	3.3150+03	5.1000+02	1.3641+03	1.3408+03	1.3454+03	
6	3.3150+03	7.4500+02	1.3849+03	1.3617+03	1.3658+03	2.4430+03
7	4.0150+03	5.4500+02	1.3461+03	1.3168+03	1.3249+03	

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	306	314	322	330	338	346
	PBC 6	PBC 7	PBC 8	PBC 9	PBC 10	PBC 11
1		2.0167+03	2.0566+03	2.1222+03	2.1401+03	2.1120+03
2		2.1315+03	2.1174+03	2.1177+03	2.1005+03	2.1075+03
3	2.1875+03	2.1181+03	2.1094+03	2.1173+03	2.1029+03	2.1061+03
4	2.1342+03	2.1232+03	2.1201+03	2.1194+03	2.1041+03	2.1109+03
5	2.1390+03	2.1307+03	2.1323+03	2.1287+03	2.1106+03	2.1150+03
6	2.1474+03	2.1354+03	2.1314+03	2.1251+03	2.1154+03	2.1163+03
7	1.9008+03	1.9480+03	1.9824+03	2.0447+03	2.0615+03	2.0971+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	362	370	380	389	461	470
	PBC 13	PBC 14	TPBOUT	TPBOUT	TWO 24	TWO 25
1	2.1519+03	2.1019+03	2.1037+03	2.1082+03	2.1373+03	2.1380+03
2	2.0927+03	2.0971+03	2.1064+03	2.1086+03	2.1368+03	2.1386+03
3	2.0914+03	2.0937+03	2.1026+03	2.1038+03	2.1333+03	2.1341+03
4	2.0949+03	2.0966+03	2.1049+03	2.1051+03	2.1328+03	2.1355+03
5	2.0980+03	2.0982+03	2.1062+03	2.1062+03	2.1339+03	2.1347+03
6	2.1004+03	2.1000+03	2.1074+03	2.1066+03	2.1330+03	2.1347+03
7	2.0719+03	2.0803+03	2.0932+03	2.0996+03	2.1614+03	2.2373+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	479	488	497	515	524	533
	TWO 26	TWO 27	TWO 31	TTSOUT	TTSOUT	TTSOUT
1	2.1354+03	2.1314+03	2.1317+03	2.0883+03	2.1058+03	2.1070+03
2	2.1349+03	2.1314+03	2.1312+03	2.0853+03	2.1057+03	2.1066+03
3	2.1295+03	2.1259+03	2.1267+03	2.1019+03	2.1016+03	2.1022+03
4	2.1309+03	2.1272+03	2.1273+03	2.1029+03	2.1039+03	2.1040+03
5	2.1304+03	2.1274+03	2.1274+03	2.1027+03	2.1030+03	2.1038+03
6	2.1300+03	2.1276+03	2.1277+03	2.1024+03	2.1023+03	2.1033+03
7	2.1660+03		2.1533+03	2.0967+03	2.0971+03	2.0971+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	540	547	561	568	575	582
	MAGNET	CND 37	CND 39	CND 40	CND 41	CND 42
1	5.0156+02	2.0855+03	1.2179+03	1.1044+03	1.0783+03	1.0483+03
2	5.1921+02	2.0848+03	1.2556+03	1.1313+03	1.1044+03	1.0733+03
3	5.3881+02	2.0797+03	1.3108+03	1.1696+03	1.1398+03	1.1065+03
4	5.5396+02	2.0784+03	1.3673+03	1.2070+03	1.1679+03	1.1368+03
5	5.7030+02	2.0776+03	1.4297+03	1.2471+03	1.2092+03	1.1691+03
6	5.8648+02	2.0757+03	1.5182+03	1.2990+03	1.2560+03	1.2100+03
7	5.3878+02	2.0709+03	1.3596+03	1.2027+03	1.1694+03	1.1336+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	589	596	603	610	617	624
	CND 43	CND 44	CND 45	CND 46	CND 47	PBRADS
1	1.0189+03	9.7161+02	9.7232+02	9.4763+02	9.3134+02	8.1535+02
2	1.0433+03	9.9395+02	9.9356+02	9.6788+02	9.5100+02	8.5503+02
3	1.0749+03	1.0237+03	1.0220+03	9.9615+02	9.7659+02	8.9955+02
4	1.1034+03	1.0505+03	1.0476+03	1.0197+03	9.9821+02	9.3488+02
5	1.1329+03	1.0780+03	1.0741+03	1.0446+03	1.0213+03	9.6721+02
6	1.1690+03	1.1104+03	1.1041+03	1.0724+03	1.0477+03	9.9897+02
7	1.1006+03	1.0491+03	1.0449+03	1.0174+03	9.9602+02	8.1476+02

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	631	638	645	652	659	666
	PBRADS	PBRADS	PBRADS	PBRADS	PBRADS	TSRADS
1	8.4840+02	7.7741+02	7.9204+02	7.6073+02	8.0853+02	1.0015+03
2	8.8352+02	8.2434+02	8.4681+02	8.3754+02	8.8684+02	1.0714+03
3	9.2334+02	8.6940+02	8.9163+02	8.8329+02	9.2710+02	1.0738+03
4	9.5588+02	9.0651+02	9.2659+02	9.1968+02	9.5932+02	1.0819+03
5	9.8737+02	9.4104+02	9.5943+02	9.5305+02	9.9006+02	1.0877+03
6	1.0177+03	9.7450+02	9.9148+02	9.8507+02	1.0204+03	1.0946+03
7	8.4794+02	7.8441+02	7.8979+02	7.8185+02	8.3934+02	1.2657+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	673	680	687	708	715	774
	TSRADS	TSRADS	TSRADS	TSRADS	TSRADS	QN PB
1	9.9507+02	9.7546+02	9.6906+02	1.0030+03	1.0097+03	8.9817+00
2	1.0719+03	1.0710+03	1.0736+03	1.0996+03	1.0998+03	1.0710+01
3	1.0743+03	1.0716+03	1.0762+03	1.1030+03	1.1032+03	1.3657+01
4	1.0825+03	1.0791+03	1.0849+03	1.1096+03	1.1098+03	1.6017+01
5	1.0883+03	1.0857+03	1.0910+03	1.1140+03	1.1142+03	1.8626+01
6	1.0953+03	1.0928+03	1.0990+03	1.1199+03	1.1201+03	2.1468+01
7	1.2662+03	1.2605+03	1.2716+03	1.2844+03	1.2846+03	7.1919+00

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

780	784	802	804	807	816
QN TS	Q/A TS	FLOW	G	P SAT	X PB
1 9.6365+00	1.1863+05	4.4894-02	4.5904+01	2.0090+02	1.5223-02
2 8.1103+00	9.9845+04	4.4874-02	4.5884+01	2.0029+02	7.2054-02
3 8.0656+00	9.9294+04	4.4578-02	4.5581+01	2.0174+02	1.6794-01
4 7.9288+00	9.7610+04	4.4236-02	4.5231+01	2.0267+02	2.4892-01
5 7.9796+00	9.8236+04	4.3388-02	4.4364+01	2.0242+02	3.4231-01
6 8.0054+00	9.8553+04	4.3148-02	4.4119+01	2.0215+02	4.3793-01
7 1.7825+01	2.1944+05	4.5104-02	4.6118+01	1.9913+02	-1.6612-02

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	823	825	828	1038	1045	1052
	X TS	ENTOUT	VELOUT	TWI 24	TWI 25	TWI 26
1	2.9943-01	7.2397+02	3.9677+01	2.1090+03	2.1097+03	2.1071+03
2	3.1226-01	7.3302+02	4.1472+01	2.1130+03	2.1147+03	2.1110+03
3	4.0651-01	8.0131+02	5.3277+01	2.1096+03	2.1104+03	2.1058+03
4	4.8534-01	8.5830+02	6.2849+01	2.1095+03	2.1122+03	2.1076+03
5	5.8521-01	9.3011+02	7.4416+01	2.1105+03	2.1112+03	2.1070+03
6	6.8314-01	1.0005+03	8.6496+01	2.1095+03	2.1112+03	2.1065+03
7	5.0295-01	8.7009+02	6.7493+01	2.1091+03	2.1853+03	2.1137+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	1053	1054	1059	1060	1061	1066
	DT 26	H 26	TWI 27	DT 27	H 27	TWI 31
1	6.7175+00	1.7660+04	2.1031+03	2.7072+00	4.3822+04	2.1034+03
2	1.1838+01	8.4344+03	2.1075+03	8.3069+00	1.2019+04	2.1073+03
3	3.8430+00	2.5838+04	2.1022+03	2.9626-01	3.3515+05	2.1030+03
4	3.9748+00	2.4557+04	2.1039+03	2.9269-01	3.3349+05	2.1039+03
5	3.8236+00	2.5692+04	2.1039+03	7.4304-01	1.3221+05	2.1040+03
6	3.8220+00	2.5786+04	2.1040+03	1.3636+00	7.2277+04	2.1042+03
7	1.6742+01	1.3107+04				2.1010+03

100 KW BOILING DATA .423-IN. TUBE, NO INSERT

	1067	1068
	DT 31	H 31
1	3.0013+00	3.9528+04
2	8.1393+00	1.2267+04
3	1.0549+00	9.4124+04
4	3.2294-01	3.0226+05
5	7.8754-01	1.2474+05
6	1.5262+00	6.4572+04
7	4.0394+00	5.4324+04

APPENDIX C

CONDENSING TEST SECTION
MECHANICAL DESIGN DESCRIPTION (50 KW PROJECT)

CONDENSING TEST SECTION
MECHANICAL DESIGN DESCRIPTION (50 KW PROJECT)
R.R. Oliver

A description of the condensing test section equipment used in the condensing tests under the 50 KW Project is summarized here for convenient reference.

The heat exchangers used in these experiments were single tube, parallel counter-current flow devices with the potassium condensation occurring inside the center tube and with the sodium cooling flow located in a surrounding concentric tube. Figure C1 shows the flow path arrangement in a schematic type drawing. Operation of this test equipment in the facility was with the condensing tube axis vertical and with the potassium in vertical down-flow.

The whole test section, but particularly the tubes where condensation occurs, are of a highly specialized design to suit the type and quantity of instrumentation required. The condensing tubes used were made of INCO Nickel 270 material which was selected because of its high purity and uniform heat conductivity in combination with its compatibility with the alkali metal environment of the test. Two different size tubes were used in the testing: both were 2-inch outside diameter by 38 inches long; one had a 5/8-inch inside diameter hole and the other a 3/8-inch inside diameter hole. The center holes were concentric with the outside diameter of the tube to within 0.003-inch.

Ten thermocouples were used to determine condensing tube wall temperatures. These thermocouples were located in holes which entered the bar, five from each end, and ran parallel to

the center hole or axis of the tube. These thermocouple
holes were 0.050 inch in diameter by 9 inches deep and
their location was held within 0.004 inch of the true
location for their entire length. The holes were located
at different radial locations: two as close as possible to
the inside diameter; one at an intermediate radius; and two
more near the outside diameter. The location of these
thermocouple holes is indicated on Figure C1 and shows more
clearly in Figure C2. Figure C2 is an enlarged photo
(approximately 2x) of one end of the 3/8-inch inside diameter
test piece. Figure C3 also shows these thermocouple holes and
in addition shows one of the stainless steel pipes which were
brazed into each end of the test pieces to allow the two-inch
diameter test condensing section to be welded to the loop
potassium piping.

In addition to the potassium pipes shown in Figure C3
each end of the nickel tube was also fitted with a two-inch
diameter stainless steel tube which was welded to the outside
diameter of the test section at each end and was used to join
the nickel pipe to the surrounding, sodium containing shell.
The space between these two concentric pipes, just described,
formed an annulus open to the atmosphere through which the
thermocouples could be installed and the thermocouple leads
could be brought out. This permitted the leads to be brought
out without crossing either the sodium or potassium flow
passages and in that way avoiding the mechanical complexities
and undesirable flow disturbances that would have been caused
by attempting to get the thermocouples and their connections
across either of the fluid paths. This annulus shows in
the schematic diagram of Figure C1. The outer casing was con-

structed with two enlarged ends. These ends were made from
stainless steel pipe reducers and flat plates and were
internally baffled with perforated discs. These enlarge-
ments served as inlet and exit manifolds to assure uniform
sodium distribution in the central annulus, which was the
actual heat exchanger region. Concentricity of the conden-
sing pipe in this heat exchanger annular region was main-
tained by small spacers which were attached to each end of
the nickel test section. The needed flexibility to accommo-
date the lengthwise differential thermal expansion which
could exist between the stainless steel shell and the nickel
center tube was provided by a guided convoluted expansion
joint located at one end of the outer casing.

All the features just described can be easily seen in
Figure C1; and the external geometry of the completed 5/8-inch
inside diameter test heat exchanger is shown in Figure C4,
which is a photograph of the completed unit. Figure C4 also
shows the 3/8 -inch inside diameter condensing tube which
has its potassium end adapter pipes attached. The 3/8-inch
test section is shown located adjacent to the casing so as to
indicate the relative length and location of the condensing
tube when it is installed in the outer casing.

Figure C5 is a photo of the detailed component parts made
prior to the initial assembly.

In addition to the condensing tube wall temperature
thermocouples mentioned earlier, other instrumentation located
in the test section measured the bulk temperature of the sodium
inlet and exit fluid. Figure C6 is a photo of the end of the
completed test section which shows three thermocouple wells

located on one end in the enlarged section where the thermo-
couples for measuring bulk sodium temperature were installed,
three more were simularly located at the opposite end. Figure C7
shows the entire unit installed in the facility just prior to
application of the insulation. This figure shows the method of
mounting the entire unit in a reinforcing frame so as to prevent
distortions to the test section that might be caused by forces
resulting from thermal expansion during loop operation.

Two complete outer casings were built to go with the two
condensing tubes. This was done to allow a rapid change of test
sections for different tests or for ready exchange of test
sections due to failure of a test section.

The two test sections used for these tests had the following
testing sequence.

1. 5/8-inch inside diameter with no insert.

2. 5/8-inch inside diameter with an uninstrumented tapered
    plug insert.

3. 3/8-inch inside diameter with no insert.

4. 5/8-inch inside diameter with an instrumented helical
    insert.

5. 5/8-inch inside diameter with an instrumented straight
    plug insert.

As can be seen from this list, the majority of testing

was done with the 5/8-inch inside diameter condensing tube as it was used both with and without inserts.

The first of the inserts used consisted of a non-instrumented long tapered pin which was as long as the condensing section, and which was used to simulate a tapered tube flow channel geometry. The installed insert was held concentric with the inside diameter of the condensing tube by wire prongs located at approximately nine inches from each end. This tapered pin was also secured in an axial direction by a hair pin shaped yoke which was attached to the upstream or small end and which was tack welded to the pipe inside diameter at the field weld location above the test section. Figure C9 is a photo of this tapered pin before installation and shows both the centering wires and the supporting yoke. When installed this insert formed a converging concentric annulus as the condensing section.

The second of the inserts used in the 5/8-inch inside diameter tube was an instrumented helical insert. This consisted of a single helix with a pitch to diameter ratio of 6 which was located around a 1/4-inch outside diameter tube. Multiple thermocouples were located inside this tube. The tube was brought out of the potassium inlet pipe wall at an enlarged section upstream of the test section installed specifically for this purpose. This enlargement consisted of two eccentric reducers welded back to back. This arrangement was used for two purposes, first to permit a gradual long radius bend in the insert tube which made insertion and removal of the thermocouples possible without danger of breaking the thermocouples, and second this provided a penetration location which had the proper angle and accessibility for a good weld where the tube came through

the wall. The helical insert and the attached enlarged section for the wall penetration are shown in Figure C9.

The third insert used was very similar to the one shown in Figure C9 but was without the helix. In this insert the 1/4-inch outside diameter center tube was held concentric with the test section with wire clips in the same fashion as had been used previously with the tapered insert shown in Figure C8. This straight tube insert also contained multiple thermocouples that were the same as had been used in the helical insert.

The key assembly drawings which define these previously discussed test sections are as follows:

The 5/8-inch diameter test section is described by GE drawing No. 263E544 - Group 1, Group 3, Group 4 and Group 5 (Figures C10a and C10b).

The 3/8-inch diameter test section is defined by GE drawing No. 941D572 - Group 1 (Figure C11).

Potassium
Inlet

Sodium
Outlet

Thermocouple Hole

Sodium
Inlet

Potassium
Outlet

A A
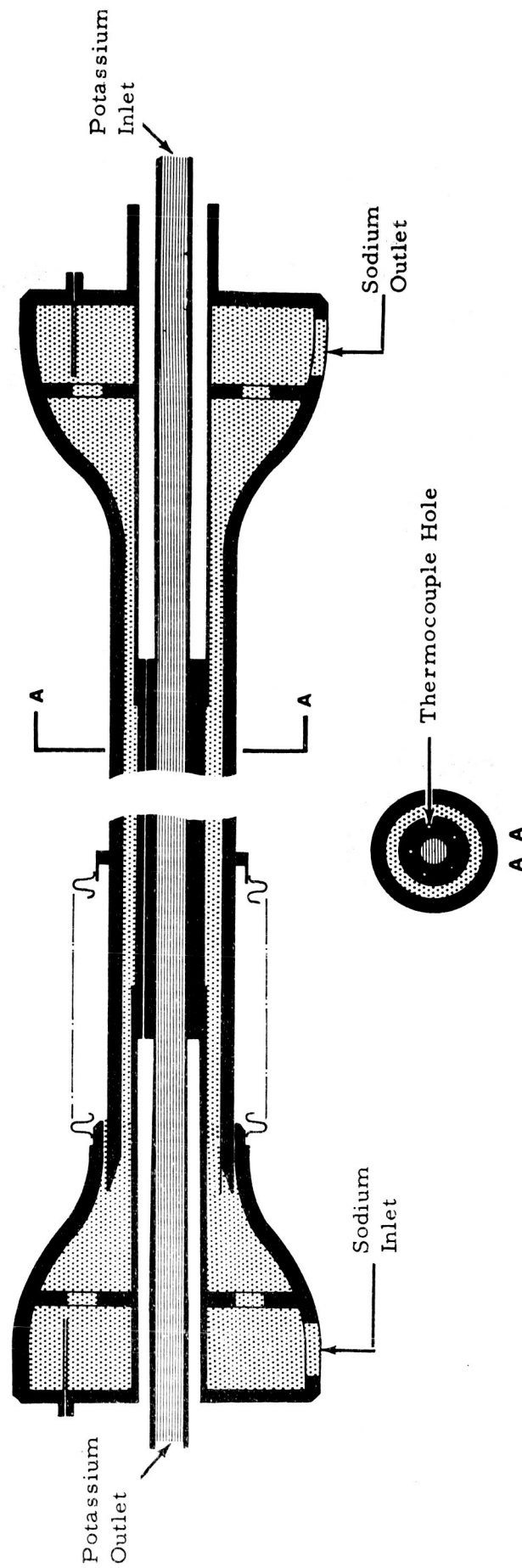
Figure C1. 50 KW Condenser Schematic Diagram.
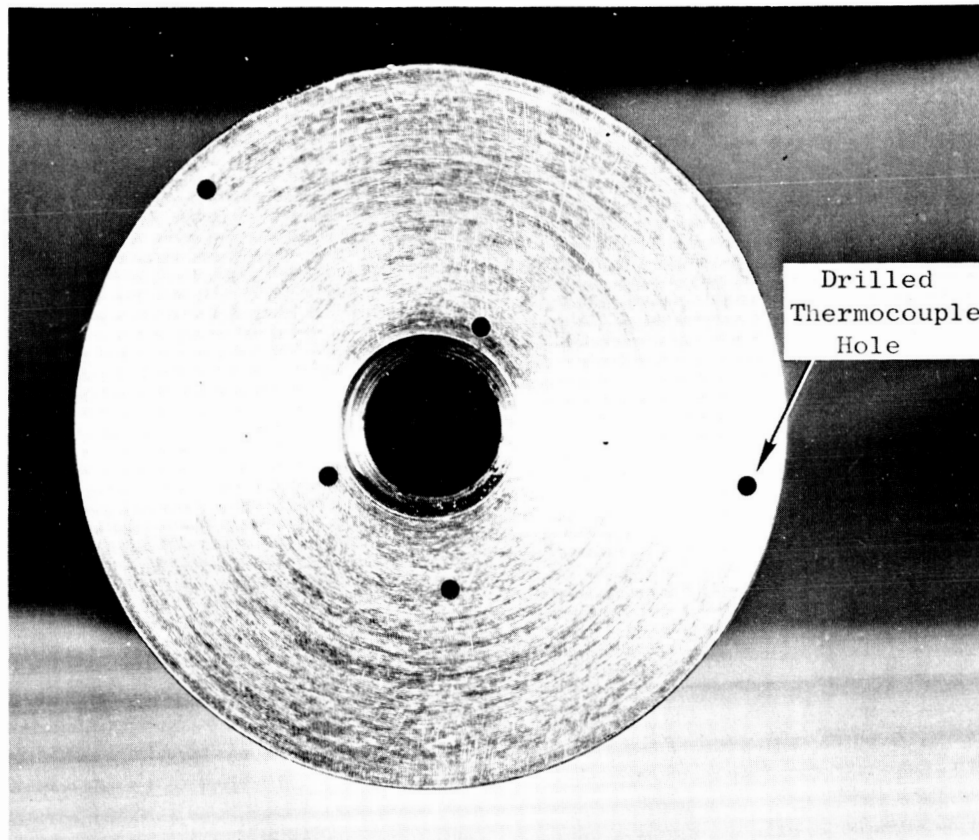
Figure C2. End View of 3/8-Inch ID Condensing Tube (Showing Drilled Thermocouple Holes).
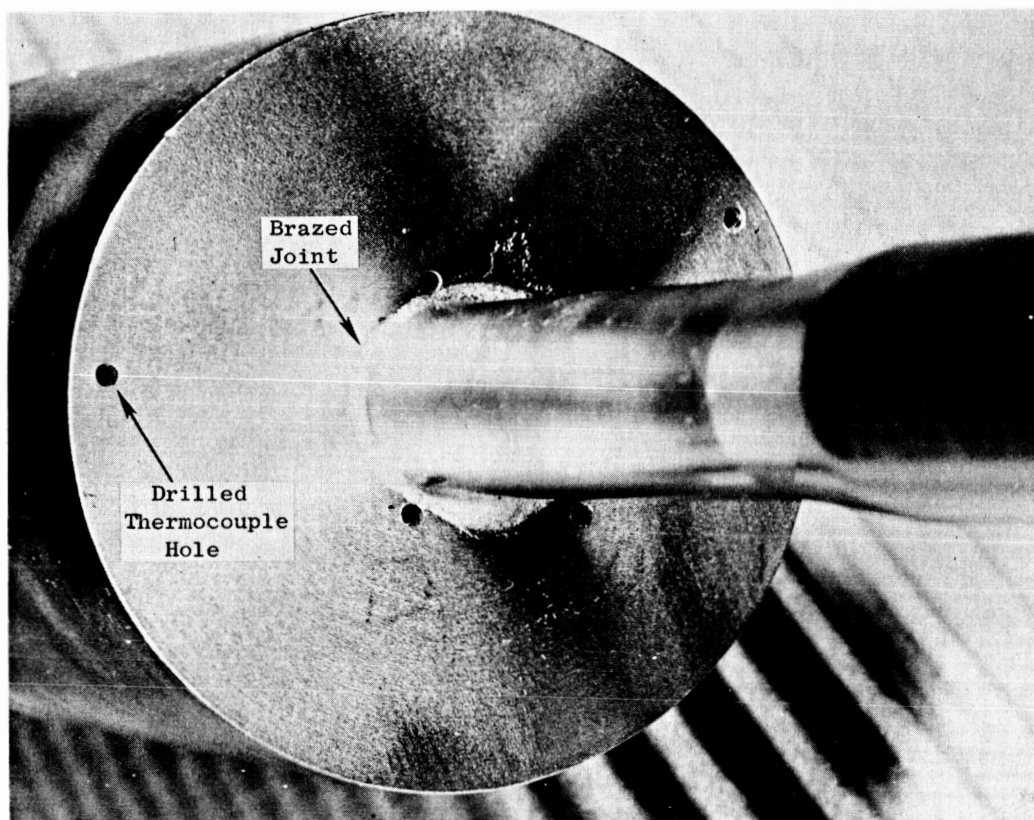
Figure C3.   End View of 3/8-Inch ID Condensing Tube (Showing
Adapter Pipe for Potassium).
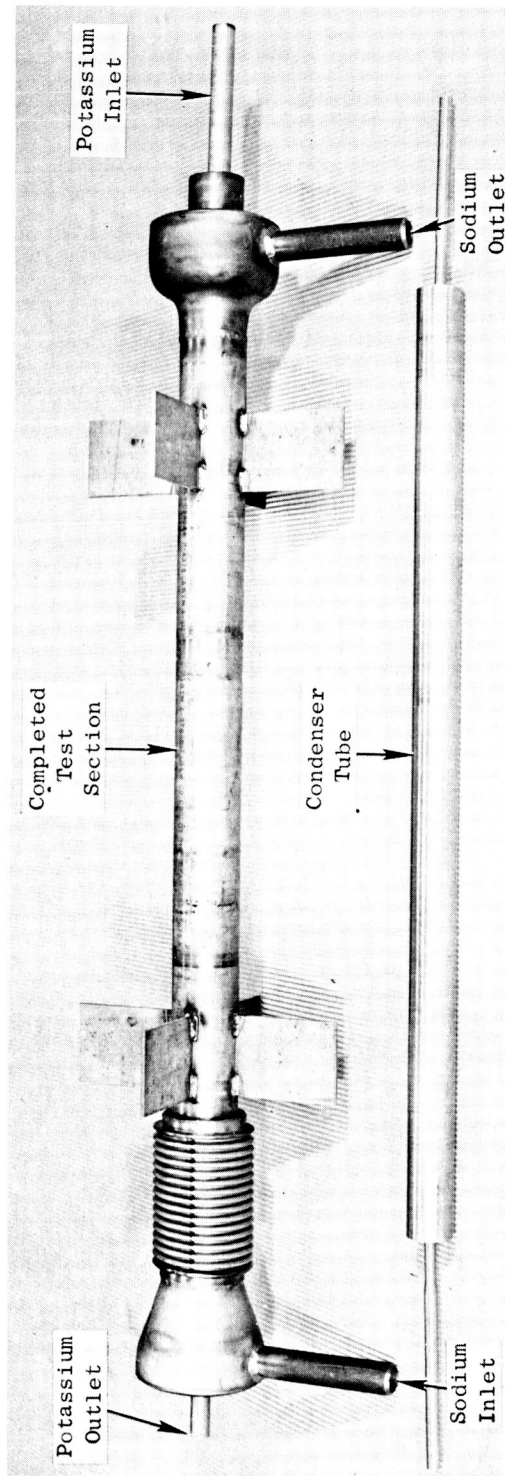
Figure C4. 5/8 Inch ID Test Condenser and 3/8-Inch ID Condenser Tube.
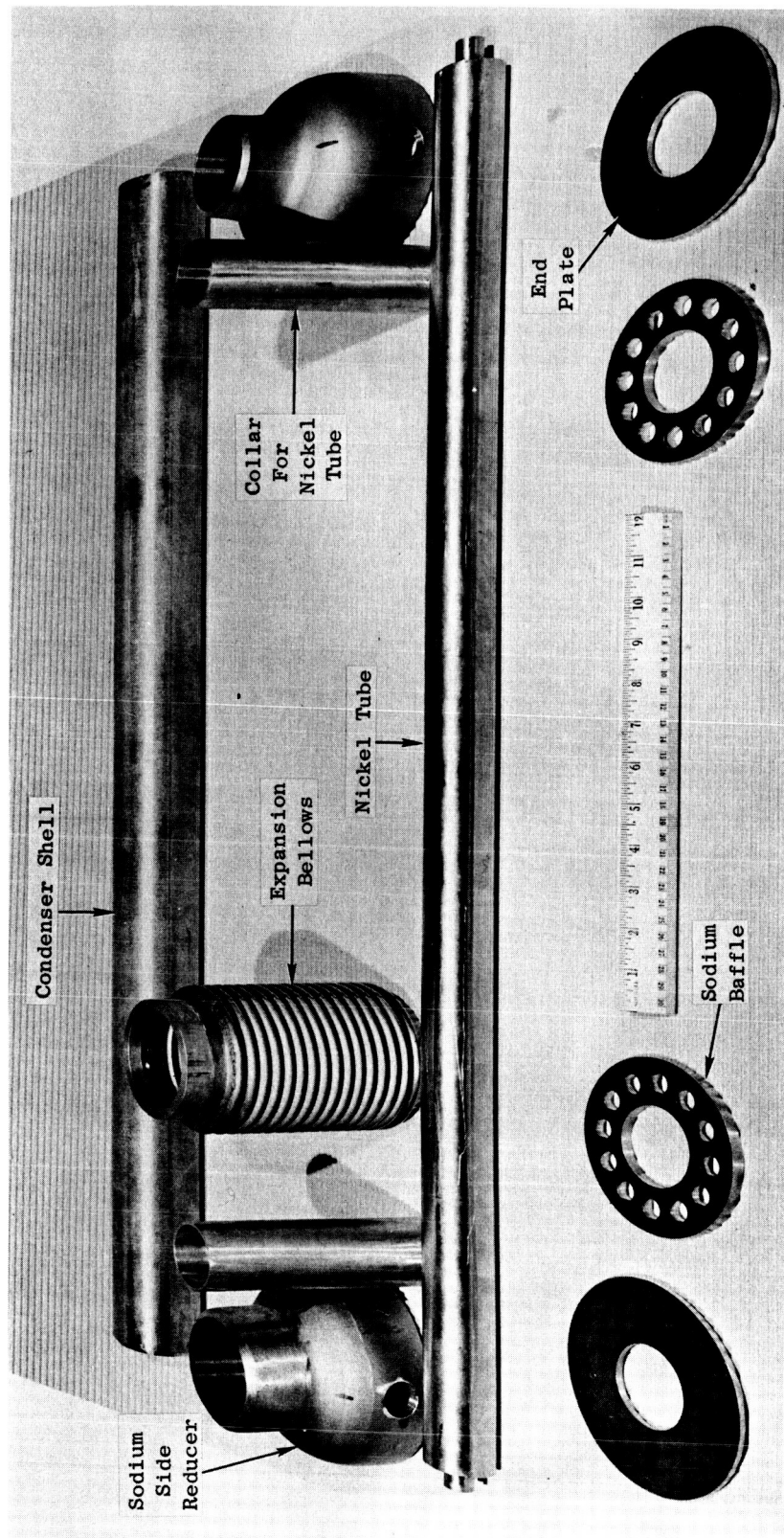
Figure C5. Test Condenser Detail Components.

Expansion
Bellows

Sodium
Inlet

Sodium Thermocouple
Well

Potassium
Outlet
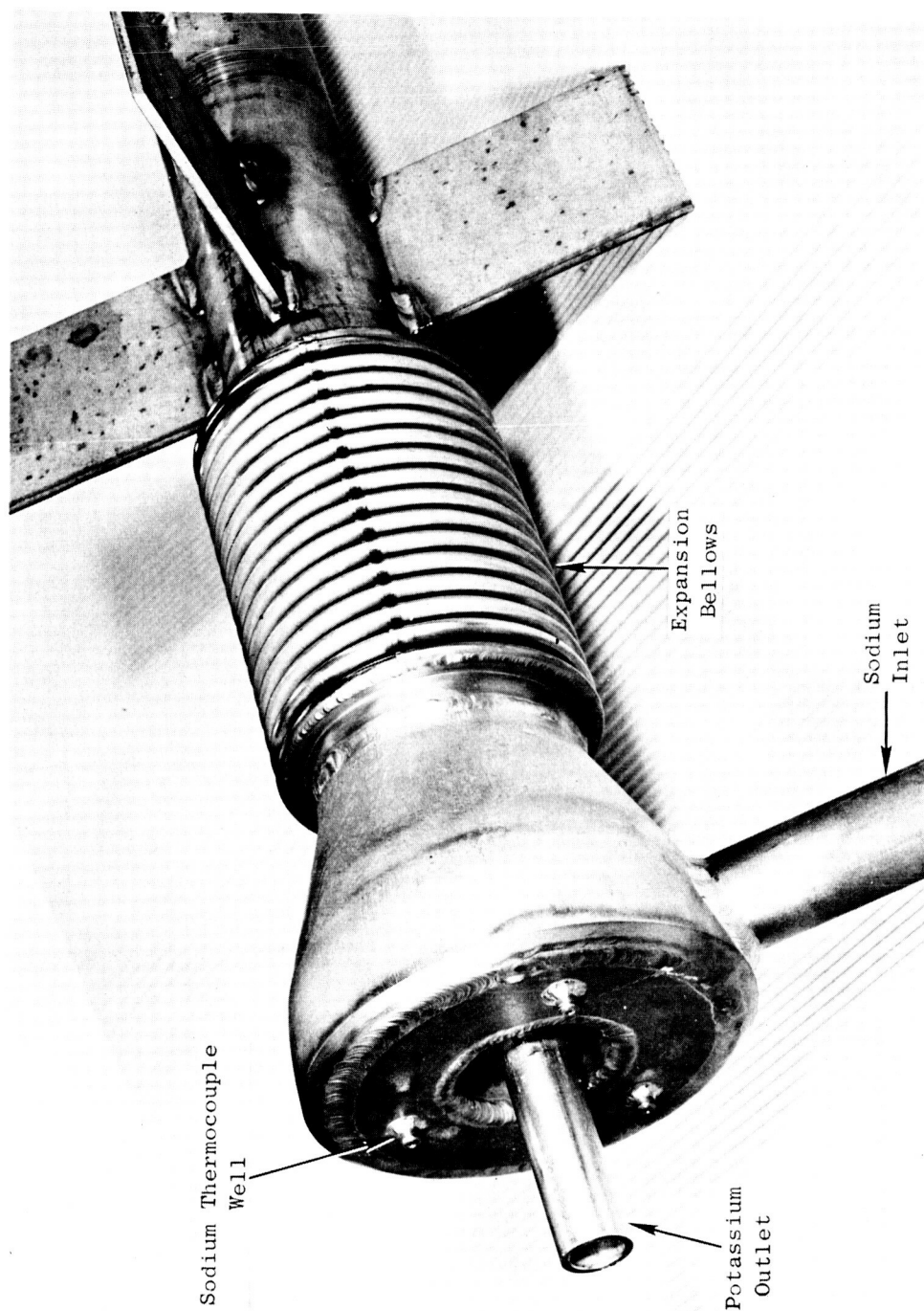
Figure C6. End View of Test Condenser Shell.
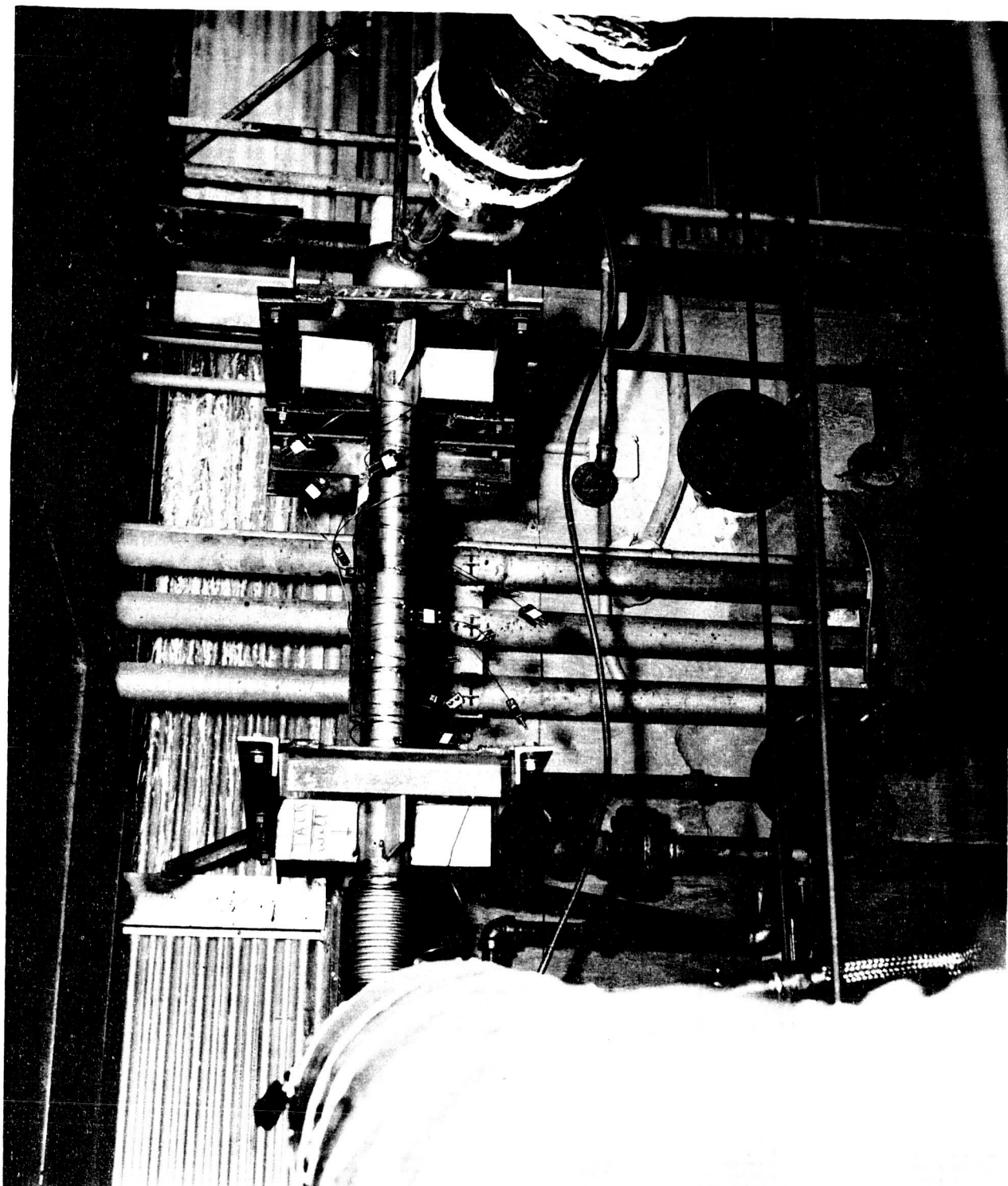
Figure C7. Condenser Installation.
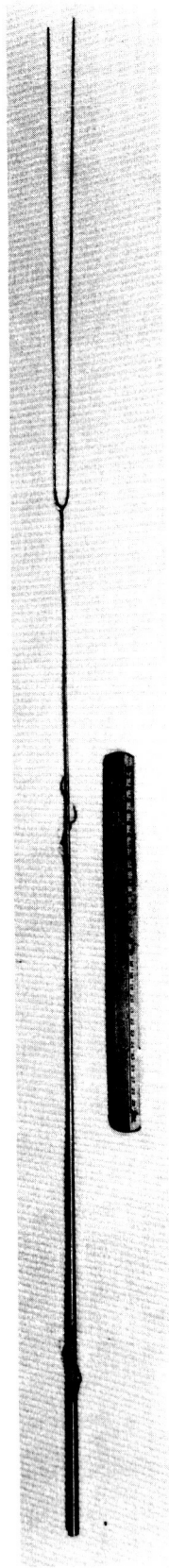
Figure C8. Tapered Pin Insert

a) Insert

b) Penetration

Figure C9. Helical Insert.

Figure 010₀₀ 5/8-inch ID Test Section Assembly Drawing.

Figure C10b. 5/8-inch ID Test Section Assembly Drawing.

Figure C11. 3/8-inch ID Test Section Assembly Drawing.

APPENDIX D

50 KW DATA

K Inlet

0.627-inch I.D.

Wall Thermocouple

SS 316 Collar

Sodium

1.85-inch O.D.

6-inch

Tapered Pin Insert

Active Condensing
Length = 36 inches

8-inch

Sodium

Wall Thermocouple

K Outlet
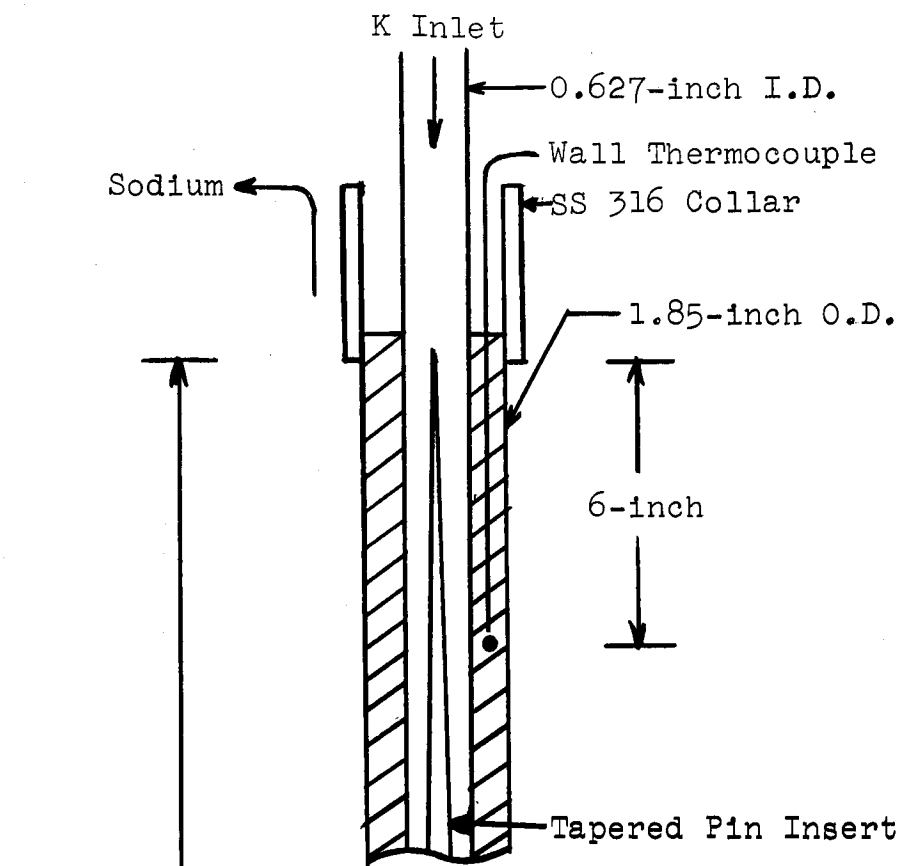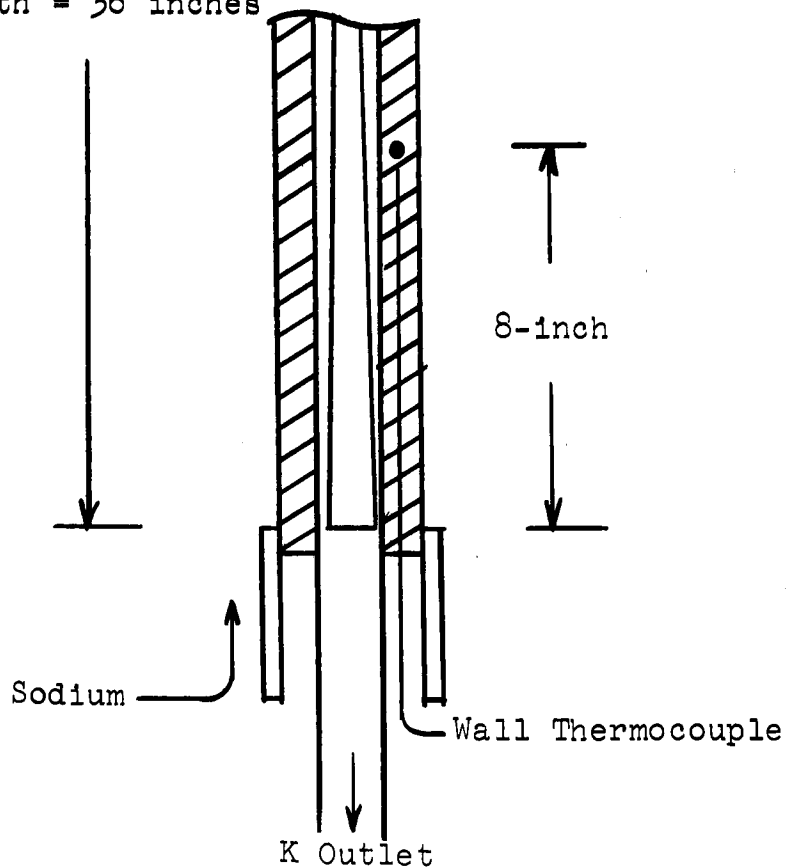
50 KW Test Section Schematic

(5/8-inch I.D. tube with tapered pin insert, Test Set
No. 2, December, 1964)

TABLE D-1. NOMENCLATURE FOR CONDENSING HEAT TRANSFER
RESULTS FROM THE 50 KW FACILITY
(Key to Table D-2)

Column	Symbol	Identification
131	DATE	(e.g., 1.2074 + 04 = 12/7/64)
132	TIME	(e.g., 1.000 + 03 = 1000)

Fluid Thermocouples

	TC Number	
134	1	Potassium inlet
136	2	Potassium inlet
138	3	Potassium outlet
140	4	Potassium outlet
142	5	Sodium outlet
144	6	Sodium outlet
146	7	Sodium outlet
148	8	Sodium inlet
150	9	Sodium inlet
152	10	Sodium inlet

Wall Thermocouples

	TC Number	Radius Within Tube Wall - Inches	Distance from Condense Inlet - Inches
154	11	.409	6
156	12	.400	6
158	13	.539	6
160	14	.834	6
162	15	.832	6
164	16	.408	28
166	17	.411	28
168	18	.541	28
170	19	.837	28
172	20	.833	28

Column	Symbol	Identification
174	TKI	Inlet potassium temperature, $^{\circ}F$
176	TKO	Outlet potassium temperature, $^{\circ}F$
181-219	TKNC	Corrected temperature of thermocouple N, $^{\circ}F$
221	TKICC	Corrected inlet potassium temperature, $^{\circ}F$
223	TKOC	Corrected outlet potassium temperature, $^{\circ}F$
226	TNAO	Outlet Sodium temperature, $^{\circ}F$
229	TNAI	Inlet Sodium temperature, $^{\circ}F$
230	DTNA	Sodium temperature increase, $^{\circ}F$
235	WNA	Sodium Flow rate, lb/hr
237	TNAM	Sodium mean temperature, $^{\circ}F$
238	CPNA	Sodium specific heat, Btu/lb-$^{\circ}F$
240	QNA	Sodium heat gain, Btu/hr
243	DTQL	Temperature Difference, Test Section Shell - Ambient, $^{\circ}F$
246	QC	Condenser load, Btu/hr
247	Q/AA	Average heat flux, Btu/hr-ft^2
251	WK	Potassium flow rate, lb/hr
306	TWIT*	Inner wall temperature at top axial station, $^{\circ}F$
317	Q/AT*	Heat Flux at inner wall at top axial station, Btu/hr-ft^2
319	TWOT*	Outer wall temperature at top axial station, $^{\circ}F$
324	HCONT*	Condensing heat transfer coefficient at top axial station, Btu/hr-ft^2 $^{\circ}F$
326	NUCT*	Nusselt's condensing ratio at top axial station, dimensionless
354	TWIB*	Inner wall temperature at bottom axial station, $^{\circ}F$
365	Q/AB*	Heat flux at inner wall at bottom axial station, Btu/hr-ft^2
367	TWOB*	Outer wall temperature at bottom axial station, $^{\circ}F$
372	HCONB*	Condensing heat transfer coefficient at bottom axial station, Btu/hr-ft^2 $^{\circ}F$
374	NUCB*	Nusselt's condensing ratio at bottom axial station, dimensionless
450	PSI HD	Inlet vapor velocity head, psi
451	PI*	Inlet potassium vapor pressure, lb/in^2
452	PO*	Outlet potassium vapor pressure, lb/in^2
453	DPC*	Condensing pressure drop

*These values were also calculated, accounting for the thermo-couple standardizations obtained in the vapor standardization runs. The values of the parameters utilizing the thermocouple standardization are indicated in the columns in which the notation for the above parameters are followed by a C, e.g., TWITC is the Inner Wall Temperature at top axial station utilizing the standardized correction factor, $^{\circ}F$.

Column	Symbol	Identification
700	X B	Potassium Quality, Bottom Station, L/D = 45
495	WKL B	Local Potassium liquid flowrate at bottom station, lb/hr
701	X T	Potassium Quality, Top Station, L/D = 10
498	WKL T	Local Potassium liquid flowrate at top station, lb/hr
504	NREF T	Liquid film Reynolds number at top station, L/D = 10
507	NREF B	Liquid film Reynolds number at bottom station, L/D = 45

TABLE D-2

CONDENSING DATA REDUCTION (Test Set No. 2)

	131	132	134	136	138	140
	DATE	TIME	TC1	TC2	TC3	TC4
1	1.2074+04	1.0000+03	1.1982+03	1.1868+03	1.2060+03	1.1922+03
2	1.2074+04	1.0000+03	1.1982+03	1.1867+03	1.2059+03	1.1921+03
3	1.2074+04	1.0000+03	1.1982+03	1.1868+03	1.2061+03	1.1924+03
4	1.2074+04	1.3000+03	1.2921+03	1.2797+03	1.2463+03	1.2321+03
5	1.2074+04	1.3000+03	1.2921+03	1.2798+03	1.2482+03	1.2339+03
6	1.2074+04	1.3000+03	1.2921+03	1.2797+03	1.2535+03	1.2394+03
7	1.2074+04	1.9000+03	1.3981+03	1.3851+03	1.3075+03	1.2929+03
8	1.2074+04	1.9000+03	1.3981+03	1.3850+03	1.3082+03	1.2935+03
9	1.2074+04	1.9000+03	1.3978+03	1.3847+03	1.3083+03	1.2937+03
10	1.2084+04	7.4500+02	1.2989+03	1.2875+03	1.3046+03	1.2896+03
11	1.2084+04	7.4500+02	1.2990+03	1.2876+03	1.3045+03	1.2895+03
12	1.2084+04	7.4500+02	1.2990+03	1.2875+03	1.3044+03	1.2894+03
13	1.2084+04	1.3000+03	1.1984+03	1.1876+03	1.2127+03	1.1985+03
14	1.2084+04	1.3000+03	1.1984+03	1.1875+03	1.2127+03	1.1986+03
15	1.2084+04	1.3000+03	1.1984+03	1.1876+03	1.2127+03	1.1985+03
16	1.2084+04	1.8300+03	1.1975+03	1.1866+03	1.2148+03	1.2006+03
17	1.2084+04	1.8300+03	1.1975+03	1.1865+03	1.2107+03	1.1974+03
18	1.2084+04	1.8300+03	1.1978+03	1.1870+03	1.2144+03	1.2000+03
19	1.2084+04	2.2150+03	1.2919+03	1.2806+03	1.3001+03	1.2851+03
20	1.2084+04	2.2150+03	1.2918+03	1.2804+03	1.2999+03	1.2852+03
21	1.2084+04	2.2150+03	1.2922+03	1.2806+03	1.2997+03	1.2848+03
22	1.2094+04	2.4500+02	1.4191+03	1.4066+03	1.4219+03	1.4054+03
23	1.2094+04	2.4500+02	1.4191+03	1.4066+03	1.4219+03	1.4054+03
24	1.2094+04	2.4500+02	1.4190+03	1.4066+03	1.4219+03	1.4056+03
25	1.2094+04	1.9300+03	1.3933+03	1.3816+03	1.3970+03	1.3809+03
26	1.2094+04	1.9300+03	1.3932+03	1.3816+03	1.3971+03	1.3811+03
27	1.2094+04	1.9300+03	1.3932+03	1.3815+03	1.3970+03	1.3810+03
28	1.2104+04	2.0000+01	1.2635+03	1.2530+03	1.2768+03	1.2620+03
29	1.2104+04	2.0000+01	1.2638+03	1.2534+03	1.2771+03	1.2623+03
30	1.2104+04	2.0000+01	1.2639+03	1.2533+03	1.2776+03	1.2628+03

CONDENSING DATA REDUCTION

	131	132	134	136	138	140
	DATE	TIME	TC1	TC2	TC3	TC4
31	1.2104+04	5.0000+02	1.1924+03	1.1835+03	1.2021+03	1.1881+03
32	1.2104+04	5.0000+02	1.1917+03	1.1829+03	1.2029+03	1.1889+03
33	1.2104+04	5.0000+02	1.1916+03	1.1828+03	1.2030+03	1.1890+03
34	1.2104+04	1.1300+03	1.2884+03	1.2781+03	1.3006+03	1.2849+03
35	1.2104+04	1.1300+03	1.2883+03	1.2781+03	1.3003+03	1.2845+03
36	1.2104+04	1.1300+03	1.2887+03	1.2784+03	1.3007+03	1.2849+03
37	1.2104+04	1.7150+03	1.3995+03	1.3883+03	1.4046+03	1.3888+03
38	1.2104+04	1.7150+03	1.3998+03	1.3887+03	1.4049+03	1.3892+03
39	1.2104+04	1.7150+03	1.3998+03	1.3887+03	1.4051+03	1.3894+03
40	1.2104+04	2.2000+03	1.3971+03	1.3861+03	1.4027+03	1.3871+03
41	1.2104+04	2.2000+03	1.3969+03	1.3859+03	1.4025+03	1.3869+03
42	1.2104+04	2.2000+03	1.3971+03	1.3861+03	1.4027+03	1.3871+03
43	1.2114+04	2.2000+02	1.3392+03	1.3289+03	1.3488+03	1.3339+03
44	1.2114+04	2.2000+02	1.3381+03	1.3279+03	1.3481+03	1.3332+03
45	1.2114+04	2.2000+02	1.3372+03	1.3271+03	1.3475+03	1.3328+03
46	1.2114+04	1.0300+03	1.2582+03	1.2488+03	1.2742+03	1.2600+03
47	1.2114+04	1.0300+03	1.2579+03	1.2487+03	1.2745+03	1.2602+03
48	1.2114+04	1.0300+03	1.2583+03	1.2491+03	1.2741+03	1.2598+03
49	1.2114+04	1.5400+03	1.2488+03	1.2375+03	1.2625+03	1.2482+03
50	1.2114+04	1.5400+03	1.2490+03	1.2377+03	1.2626+03	1.2483+03
51	1.2114+04	1.5400+03	1.2488+03	1.2375+03	1.2625+03	1.2482+03
52	1.2114+04	1.6450+03	1.2368+03	1.2270+03	1.2481+03	1.2351+03
53	1.2114+04	1.6450+03	1.2364+03	1.2265+03	1.2471+03	1.2342+03
54	1.2114+04	1.6450+03	1.2366+03	1.2267+03	1.2480+03	1.2350+03
55	1.2114+04	1.8150+03	1.2288+03	1.2189+03	1.2377+03	1.2249+03
56	1.2114+04	1.8150+03	1.2291+03	1.2191+03	1.2379+03	1.2251+03
57	1.2114+04	1.8150+03	1.2289+03	1.2190+03	1.2377+03	1.2249+03
58	1.2114+04	1.9200+03	1.2275+03	1.2176+03	1.2343+03	1.2217+03
59	1.2114+04	1.9200+03	1.2277+03	1.2178+03	1.2344+03	1.2218+03
60	1.2114+04	1.9200+03	1.2277+03	1.2178+03	1.2344+03	1.2218+03

CONDENSING DATA REDUCTION

	131 DATE	132 TIME	134 TC1	136 TC2	138 TC3	140 TC4
61	1.2114+04	2.0200+03	1.2286+03	1.2186+03	1.2335+03	1.2210+03
62	1.2114+04	2.0200+03	1.2283+03	1.2183+03	1.2334+03	1.2209+03
63	1.2114+04	2.0200+03	1.2284+03	1.2184+03	1.2334+03	1.2209+03
64	1.2114+04	2.1000+03	1.2145+03	1.2046+03	1.2196+03	1.2073+03
65	1.2114+04	2.1000+03	1.2147+03	1.2047+03	1.2197+03	1.2073+03
66	1.2114+04	2.1000+03	1.2147+03	1.2048+03	1.2198+03	1.2075+03
67	1.2124+04	1.4300+03	1.4079+03	1.3981+03	1.4189+03	1.4024+03
68	1.2124+04	1.4300+03	1.4083+03	1.3985+03	1.4197+03	1.4043+03
69	1.2124+04	1.4300+03	1.4079+03	1.3985+03	1.4200+03	1.4048+03
70	1.2124+04	1.1000+03	1.4318+03	1.4218+03	1.4384+03	1.4229+03
71	1.2124+04	1.1000+03	1.4282+03	1.4184+03	1.4367+03	1.4211+03
72	1.2124+04	1.1000+03	1.4267+03	1.4168+03	1.4343+03	1.4193+03

CONDENSING DATA REDUCTION

	142	144	146	148	150	152
	TC5	TC6	TC7	TC8	TC9	TC10
1	1.1498+03	1.1464+03	1.1311+03	1.1267+03	1.1269+03	1.1285+03
2	1.1497+03	1.1466+03	1.1311+03	1.1267+03	1.1269+03	1.1286+03
3	1.1500+03	1.1466+03	1.1313+03	1.1269+03	1.1271+03	1.1286+03
4	1.2374+03	1.2338+03	1.2172+03	1.2120+03	1.2121+03	1.2137+03
5	1.2372+03	1.2341+03	1.2171+03	1.2121+03	1.2122+03	1.2138+03
6	1.2373+03	1.2333+03	1.2171+03	1.2119+03	1.2121+03	1.2137+03
7	1.3284+03	1.3232+03	1.3060+03	1.2970+03	1.2970+03	1.2990+03
8	1.3285+03	1.3232+03	1.3059+03	1.2968+03	1.2970+03	1.2988+03
9	1.3283+03	1.3234+03	1.3060+03	1.2970+03	1.2970+03	1.2988+03
10	1.2326+03	1.2266+03	1.2109+03	1.1994+03	1.1991+03	1.2010+03
11	1.2324+03	1.2268+03	1.2107+03	1.1993+03	1.1991+03	1.2011+03
12	1.2323+03	1.2265+03	1.2107+03	1.1993+03	1.1991+03	1.2012+03
13	1.1341+03	1.1279+03	1.1129+03	1.0981+03	1.0977+03	1.0999+03
14	1.1344+03	1.1281+03	1.1132+03	1.0982+03	1.0978+03	1.10C1+03
15	1.1343+03	1.1279+03	1.1133+03	1.0982+03	1.0978+03	1.1000+03
16	1.1188+03	1.1107+03	1.0962+03	1.0708+03	1.0699+03	1.0733+03
17	1.1188+03	1.1106+03	1.0957+03	1.0711+03	1.0700+03	1.C734+03
18	1.1186+03	1.1111+03	1.0960+03	1.0709+03	1.0700+03	1.0734+03
19	1.2115+03	1.2038+03	1.1879+03	1.1650+03	1.1640+03	1.1671+03
20	1.2114+03	1.2035+03	1.1879+03	1.1652+03	1.1643+03	1.1674+03
21	1.2117+03	1.2034+03	1.1879+03	1.1649+03	1.1640+03	1.1671+03
22	1.3412+03	1.3341+03	1.3168+03	1.2992+03	1.2986+03	1.3011+03
23	1.3409+03	1.3341+03	1.3169+03	1.2991+03	1.2985+03	1.3012+03
24	1.3411+03	1.3342+03	1.3169+03	1.2994+03	1.2987+03	1.3012+03
25	1.2933+03	1.2841+03	1.2676+03	1.2389+03	1.2378+03	1.2411+03
26	1.2929+03	1.2835+03	1.2677+03	1.2390+03	1.2378+03	1.2410+03
27	1.2930+03	1.2842+03	1.2679+03	1.2389+03	1.2376+03	1.2410+03
28	1.1652+03	1.1551+03	1.1405+03	1.1076+03	1.1063+03	1.1101+03
29	1.1651+03	1.1553+03	1.1408+03	1.1077+03	1.1063+03	1.1103+03
30	1.1653+03	1.1547+03	1.1406+03	1.1076+03	1.1062+03	1.1103+03

CONDENSING DATA REDUCTION

	142	144	146	148	150	152
	TC5	TC6	TC7	TC8	TC9	TC10
31	1.0842+03	1.0753+03	1.0623+03	1.0278+03	1.0255+03	1.0299+03
32	1.0843+03	1.0755+03	1.0624+03	1.0280+03	1.0256+03	1.0300+03
33	1.0847+03	1.0760+03	1.0629+03	1.0282+03	1.0258+03	1.0302+03
34	1.1667+03	1.1544+03	1.1403+03	1.0962+03	1.0944+03	1.0988+03
35	1.1668+03	1.1538+03	1.1401+03	1.0964+03	1.0945+03	1.0989+03
36	1.1669+03	1.1543+03	1.1403+03	1.0965+03	1.0945+03	1.0990+03
37	1.2781+03	1.2670+03	1.2507+03	1.2112+03	1.2096+03	1.2132+03
38	1.2784+03	1.2669+03	1.2507+03	1.2111+03	1.2094+03	1.2130+03
39	1.2781+03	1.2666+03	1.2510+03	1.2110+03	1.2094+03	1.2129+03
40	1.2616+03	1.2479+03	1.2325+03	1.1848+03	1.1832+03	1.1871+03
41	1.2616+03	1.2478+03	1.2328+03	1.1852+03	1.1835+03	1.1875+03
42	1.2618+03	1.2479+03	1.2332+03	1.1853+03	1.1838+03	1.1875+03
43	1.2030+03	1.1890+03	1.1746+03	1.1241+03	1.1226+03	1.1265+03
44	1.2026+03	1.1884+03	1.1743+03	1.1243+03	1.1228+03	1.1267+03
45	1.2026+03	1.1891+03	1.1743+03	1.1244+03	1.1229+03	1.1268+03
46	1.1366+03	1.1241+03	1.1109+03	1.0660+03	1.0643+03	1.0679+03
47	1.1365+03	1.1244+03	1.1108+03	1.0653+03	1.0639+03	1.0675+03
48	1.1364+03	1.1244+03	1.1109+03	1.0662+03	1.0646+03	1.0684+03
49	1.1623+03	1.1549+03	1.1408+03	1.1158+03	1.1144+03	1.1171+03
50	1.1623+03	1.1549+03	1.1409+03	1.1157+03	1.1144+03	1.1172+03
51	1.1625+03	1.1553+03	1.1410+03	1.1159+03	1.1146+03	1.1173+03
52	1.1622+03	1.1568+03	1.1428+03	1.1246+03	1.1237+03	1.1258+03
53	1.1617+03	1.1564+03	1.1422+03	1.1246+03	1.1236+03	1.1258+03
54	1.1621+03	1.1567+03	1.1427+03	1.1246+03	1.1236+03	1.1259+03
55	1.1677+03	1.1644+03	1.1498+03	1.1396+03	1.1389+03	1.1407+03
56	1.1679+03	1.1643+03	1.1499+03	1.1398+03	1.1391+03	1.1408+03
57	1.1677+03	1.1642+03	1.1498+03	1.1397+03	1.1390+03	1.1408+03
58	1.1753+03	1.1728+03	1.1581+03	1.1536+03	1.1531+03	1.1546+03
59	1.1755+03	1.1729+03	1.1582+03	1.1537+03	1.1532+03	1.1546+03
60	1.1754+03	1.1728+03	1.1583+03	1.1538+03	1.1532+03	1.1547+03

CONDENSING DATA REDUCTION

	142	144	146	148	150	152
	TC5	TC6	TC7	TC8	TC9	TC10
61	1.1827+03	1.1809+03	1.1661+03	1.1656+03	1.1651+03	1.1665+03
62	1.1826+03	1.1808+03	1.1660+03	1.1656+03	1.1652+03	1.1665+03
63	1.1827+03	1.1808+03	1.1660+03	1.1656+03	1.1652+03	1.1664+03
64	1.1717+03	1.1702+03	1.1554+03	1.1566+03	1.1562+03	1.1575+03
65	1.1720+03	1.1704+03	1.1557+03	1.1568+03	1.1565+03	1.1577+03
66	1.1721+03	1.1706+03	1.1559+03	1.1574+03	1.1569+03	1.1582+03
67	1.2401+03	1.2230+03	1.2084+03	1.1458+03	1.1439+03	1.1485+03
68	1.2391+03	1.2235+03	1.2080+03	1.1464+03	1.1444+03	1.1489+03
69	1.2416+03	1.2245+03	1.2097+03	1.1456+03	1.1436+03	1.1479+03
70	1.2717+03	1.2565+03	1.2406+03	1.1809+03	1.1788+03	1.1832+03
71	1.2718+03	1.2559+03	1.2403+03	1.1803+03	1.1785+03	1.1830+03
72	1.2714+03	1.2556+03	1.2403+03	1.1809+03	1.1786+03	1.1833+03

CONDENSING DATA REDUCTION

	154	156	158	160	162	164
	TC11	TC12	TC13	TC14	TC15	TC16
1	1.1694+03	1.1911+03	1.1781+03	1.1556+03	1.1388+03	1.1725+03
2	1.1696+03	1.1913+03	1.1782+03	1.1558+03	1.1389+03	1.1727+03
3	1.1697+03	1.1913+03	1.1782+03	1.1555+03	1.1388+03	1.1724+03
4	1.2591+03	1.2823+03	1.2680+03	1.2432+03	1.2258+03	1.2613+03
5	1.2591+03	1.2825+03	1.2682+03	1.2435+03	1.2258+03	1.2612+03
6	1.2588+03	1.2823+03	1.2679+03	1.2433+03	1.2258+03	1.2613+03
7	1.3590+03	1.3847+03	1.3670+03	1.3367+03	1.3171+03	1.3589+03
8	1.3590+03	1.3847+03	1.3670+03	1.3367+03	1.3172+03	1.3592+03
9	1.3587+03	1.3844+03	1.3667+03	1.3365+03	1.3169+03	1.3588+03
10	1.2639+03	1.2871+03	1.2699+03	1.2400+03	1.2212+03	1.2634+03
11	1.2639+03	1.2871+03	1.2699+03	1.2403+03	1.2214+03	1.2635+03
12	1.2639+03	1.2871+03	1.2700+03	1.2404+03	1.2215+03	1.2636+03
13	1.1687+03	1.1895+03	1.1721+03	1.1420+03	1.1235+03	1.1693+03
14	1.1688+03	1.1896+03	1.1723+03	1.1422+03	1.1237+03	1.1693+03
15	1.1688+03	1.1897+03	1.1723+03	1.1421+03	1.1236+03	1.1694+03
16	1.1643+03	1.1853+03	1.1646+03	1.1281+03	1.1086+03	1.1627+03
17	1.1638+03	1.1848+03	1.1641+03	1.1278+03	1.1082+03	1.1621+03
18	1.1641+03	1.1852+03	1.1645+03	1.1282+03	1.1086+03	1.1625+03
19	1.2544+03	1.2771+03	1.2567+03	1.2207+03	1.2005+03	1.2510+03
20	1.2546+03	1.2772+03	1.2567+03	1.2206+03	1.2003+03	1.2510+03
21	1.2541+03	1.2766+03	1.2566+03	1.2206+03	1.2005+03	1.2506+03
22	1.3778+03	1.4031+03	1.3838+03	1.3497+03	1.3291+03	1.3754+03
23	1.3779+03	1.4033+03	1.3839+03	1.3498+03	1.3291+03	1.3756+03
24	1.3780+03	1.4034+03	1.3841+03	1.3499+03	1.3291+03	1.3754+03
25	1.3482+03	1.3725+03	1.3479+03	1.3044+03	1.2835+03	1.3412+03
26	1.3481+03	1.3725+03	1.3478+03	1.3044+03	1.2834+03	1.3409+03
27	1.3480+03	1.3724+03	1.3476+03	1.3043+03	1.2832+03	1.3408+03
28	1.2251+03	1.2468+03	1.2214+03	1.1761+03	1.1565+03	1.2182+03
29	1.2254+03	1.2471+03	1.2216+03	1.1761+03	1.1566+03	1.2185+03
30	1.2258+03	1.2475+03	1.2219+03	1.1764+03	1.1568+03	1.2190+03

CONDENSING DATA REDUCTION

	154	156	158	160	162	164
	TC11	TC12	TC13	TC14	TC15	TC16
31	1.1489+03	1.1694+03	1.1421+03	1.0955+03	1.0777+03	1.1400+03
32	1.1497+03	1.1701+03	1.1428+03	1.0963+03	1.0784+03	1.1408+03
33	1.1497+03	1.1700+03	1.1428+03	1.0962+03	1.0785+03	1.1403+03
34	1.2453+03	1.2674+03	1.2356+03	1.1801+03	1.1593+03	1.2321+03
35	1.2445+03	1.2667+03	1.2349+03	1.1797+03	1.1591+03	1.2319+03
36	1.2450+03	1.2668+03	1.2355+03	1.1801+03	1.1595+03	1.2318+03
37	1.3495+03	1.3735+03	1.3436+03	1.2914+03	1.2697+03	1.3391+03
38	1.3497+03	1.3737+03	1.3437+03	1.2912+03	1.2695+03	1.3392+03
39	1.3496+03	1.3735+03	1.3437+03	1.2912+03	1.2696+03	1.3389+03
40	1.3448+03	1.3685+03	1.3348+03	1.2758+03	1.2539+03	1.3313+03
41	1.3447+03	1.3684+03	1.3349+03	1.2756+03	1.2543+03	1.3315+03
42	1.3443+03	1.3679+03	1.3347+03	1.2765+03	1.2539+03	1.3308+03
43	1.2897+03	1.3118+03	1.2779+03	1.2172+03	1.1962+03	1.2751+03
44	1.2883+03	1.3105+03	1.2767+03	1.2169+03	1.1952+03	1.2742+03
45	1.2885+03	1.3107+03	1.2766+03	1.2161+03	1.1952+03	1.2745+03
46	1.2181+03	1.2391+03	1.2063+03	1.1495+03	1.1302+03	1.2045+03
47	1.2179+03	1.2389+03	1.2065+03	1.1497+03	1.1303+03	1.2045+03
48	1.2174+03	1.2384+03	1.2061+03	1.1496+03	1.1303+03	1.2045+03
49	1.2139+03	1.2347+03	1.2108+03	1.1718+03	1.1538+03	1.2092+03
50	1.2140+03	1.2348+03	1.2108+03	1.1719+03	1.1538+03	1.2095+03
51	1.2138+03	1.2345+03	1.2107+03	1.1719+03	1.1538+03	1.2092+03
52	1.2034+03	1.2243+03	1.2042+03	1.1704+03	1.1541+03	1.2028+03
53	1.2028+03	1.2238+03	1.2036+03	1.1698+03	1.1537+03	1.2024+03
54	1.2035+03	1.2246+03	1.2043+03	1.1705+03	1.1543+03	1.2033+03
55	1.1983+03	1.2194+03	1.2025+03	1.1748+03	1.1592+03	1.2004+03
56	1.1983+03	1.2194+03	1.2026+03	1.1749+03	1.1593+03	1.2004+03
57	1.1983+03	1.2194+03	1.2025+03	1.1747+03	1.1592+03	1.2004+03
58	1.1982+03	1.2193+03	1.2048+03	1.1814+03	1.1661+03	1.2018+03
59	1.1983+03	1.2194+03	1.2048+03	1.1814+03	1.1662+03	1.2018+03
60	1.1983+03	1.2194+03	1.2050+03	1.1814+03	1.1662+03	1.2018+03

CONDENSING DATA REDUCTION

	154 TC11	156 TC12	158 TC13	160 TC14	162 TC15	164 TC16
61	1.2000+03	1.2212+03	1.2085+03	1.1880+03	1.1729+03	1.2046+03
62	1.2000+03	1.2211+03	1.2083+03	1.1880+03	1.1729+03	1.2046+03
63	1.1999+03	1.2211+03	1.2083+03	1.1879+03	1.1728+03	1.2046+03
64	1.1871+03	1.2079+03	1.1959+03	1.1767+03	1.1620+03	1.1922+03
65	1.1872+03	1.2080+03	1.1961+03	1.1769+03	1.1621+03	1.1924+03
66	1.1873+03	1.2081+03	1.1962+03	1.1772+03	1.1624+03	1.1926+03
67	1.3414+03	1.3634+03	1.3269+03	1.2583+03	1.2338+03	1.3207+03
68	1.3492+03	1.3729+03	1.3314+03	1.2597+03	1.2360+03	1.3325+03
69	1.3503+03	1.3743+03	1.3324+03	1.2605+03	1.2361+03	1.3336+03
70	1.3739+03	1.3980+03	1.3586+03	1.2903+03	1.2657+03	1.3566+03
71	1.3710+03	1.3954+03	1.3563+03	1.2897+03	1.2643+03	1.3550+03
72	1.3707+03	1.3950+03	1.3557+03	1.2883+03	1.2640+03	1.3546+03

CONDENSING DATA REDUCTION

	166	168	170	172	174	176
	TC17	TC18	TC19	TC20	TKI	TKO
1	1.1886+03	1.1733+03	1.1468+03	1.1437+03	1.1925+03	1.1991+03
2	1.1887+03	1.1733+03	1.1467+03	1.1435+03	1.1924+03	1.1990+03
3	1.1885+03	1.1733+03	1.1467+03	1.1436+03	1.1925+03	1.1993+03
4	1.2781+03	1.2622+03	1.2338+03	1.2302+03	1.2859+03	1.2392+03
5	1.2780+03	1.2621+03	1.2336+03	1.2301+03	1.2860+03	1.2410+03
6	1.2779+03	1.2621+03	1.2339+03	1.2303+03	1.2859+03	1.2464+03
7	1.3781+03	1.3584+03	1.3221+03	1.3186+03	1.3916+03	1.3002+03
8	1.3784+03	1.3585+03	1.3221+03	1.3186+03	1.3915+03	1.3008+03
9	1.3781+03	1.3584+03	1.3224+03	1.3187+03	1.3912+03	1.3010+03
10	1.2823+03	1.2626+03	1.2259+03	1.2222+03	1.2932+03	1.2971+03
11	1.2823+03	1.2627+03	1.2260+03	1.2225+03	1.2933+03	1.2970+03
12	1.2824+03	1.2626+03	1.2259+03	1.2224+03	1.2932+03	1.2969+03
13	1.1884+03	1.1661+03	1.1266+03	1.1232+03	1.1930+03	1.2056+03
14	1.1885+03	1.1661+03	1.1264+03	1.1232+03	1.1929+03	1.2057+03
15	1.1884+03	1.1661+03	1.1264+03	1.1232+03	1.1930+03	1.2056+03
16	1.1838+03	1.1556+03	1.1063+03	1.1030+03	1.1921+03	1.2077+03
17	1.1833+03	1.1553+03	1.1064+03	1.1030+03	1.1920+03	1.2040+03
18	1.1836+03	1.1555+03	1.1064+03	1.1031+03	1.1924+03	1.2072+03
19	1.2719+03	1.2462+03	1.1997+03	1.1959+03	1.2863+03	1.2926+03
20	1.2718+03	1.2461+03	1.1997+03	1.1959+03	1.2861+03	1.2925+03
21	1.2714+03	1.2459+03	1.1995+03	1.1956+03	1.2864+03	1.2923+03
22	1.3963+03	1.3738+03	1.3318+03	1.3274+03	1.4129+03	1.4137+03
23	1.3965+03	1.3739+03	1.3318+03	1.3272+03	1.4128+03	1.4137+03
24	1.3964+03	1.3738+03	1.3316+03	1.3271+03	1.4128+03	1.4137+03
25	1.3640+03	1.3342+03	1.2792+03	1.2748+03	1.3874+03	1.3890+03
26	1.3637+03	1.3340+03	1.2791+03	1.2748+03	1.3874+03	1.3891+03
27	1.3635+03	1.3338+03	1.2790+03	1.2747+03	1.3874+03	1.3890+03
28	1.2413+03	1.2083+03	1.1489+03	1.1456+03	1.2583+03	1.2694+03
29	1.2417+03	1.2084+03	1.1489+03	1.1456+03	1.2586+03	1.2697+03
30	1.2421+03	1.2088+03	1.1490+03	1.1458+03	1.2586+03	1.2702+03

CONDENSING DATA REDUCTION

	166	168	170	172	174	176
	TC17	TC18	TC19	TC20	TKI	TKO
31	1.1629+03	1.1281+03	1.0681+03	1.0657+03	1.1879+03	1.1951+03
32	1.1638+03	1.1289+03	1.0684+03	1.0663+03	1.1873+03	1.1959+03
33	1.1632+03	1.1284+03	1.0683+03	1.0663+03	1.1872+03	1.1960+03
34	1.2574+03	1.2177+03	1.1457+03	1.1423+03	1.2832+03	1.2927+03
35	1.2572+03	1.2176+03	1.1461+03	1.1422+03	1.2832+03	1.2924+03
36	1.2573+03	1.2175+03	1.1458+03	1.1422+03	1.2835+03	1.2928+03
37	1.3636+03	1.3271+03	1.2591+03	1.2554+03	1.3939+03	1.3967+03
38	1.3637+03	1.3272+03	1.2589+03	1.2556+03	1.3943+03	1.3971+03
39	1.3634+03	1.3269+03	1.2591+03	1.2553+03	1.3943+03	1.3972+03
40	1.3573+03	1.3158+03	1.2391+03	1.2350+03	1.3916+03	1.3949+03
41	1.3574+03	1.3159+03	1.2396+03	1.2352+03	1.3914+03	1.3947+03
42	1.3568+03	1.3154+03	1.2391+03	1.2350+03	1.3916+03	1.3949+03
43	1.3011+03	1.2582+03	1.1795+03	1.1751+03	1.3341+03	1.3413+03
44	1.3003+03	1.2576+03	1.1791+03	1.1752+03	1.3330+03	1.3407+03
45	1.3006+03	1.2577+03	1.1791+03	1.1753+03	1.3322+03	1.3401+03
46	1.2297+03	1.1886+03	1.1151+03	1.1120+03	1.2535+03	1.2671+03
47	1.2297+03	1.1887+03	1.1152+03	1.1119+03	1.2533+03	1.2674+03
48	1.2296+03	1.1886+03	1.1153+03	1.1122+03	1.2537+03	1.2669+03
49	1.2307+03	1.2028+03	1.1505+03	1.1464+03	1.2432+03	1.2553+03
50	1.2310+03	1.2029+03	1.1504+03	1.1464+03	1.2434+03	1.2554+03
51	1.2308+03	1.2028+03	1.1505+03	1.1465+03	1.2432+03	1.2554+03
52	1.2214+03	1.1975+03	1.1535+03	1.1514+03	1.2319+03	1.2416+03
53	1.2210+03	1.1971+03	1.1532+03	1.1510+03	1.2314+03	1.2407+03
54	1.2221+03	1.1978+03	1.1536+03	1.1515+03	1.2316+03	1.2415+03
55	1.2171+03	1.1984+03	1.1627+03	1.1608+03	1.2239+03	1.2313+03
56	1.2171+03	1.1985+03	1.1629+03	1.1607+03	1.2241+03	1.2315+03
57	1.2171+03	1.1984+03	1.1628+03	1.1608+03	1.2240+03	1.2313+03
58	1.2170+03	1.2021+03	1.1726+03	1.1708+03	1.2226+03	1.2280+03
59	1.2171+03	1.2022+03	1.1727+03	1.1708+03	1.2227+03	1.2281+03
60	1.2171+03	1.2023+03	1.1726+03	1.1709+03	1.2228+03	1.2281+03

CONDENSING DATA REDUCTION

	166	168	170	172	174	176
	TC17	TC18	TC19	TC20	TKI	TKO
61	1.2188+03	1.2069+03	1.1816+03	1.1799+03	1.2236+03	1.2273+03
62	1.2188+03	1.2068+03	1.1816+03	1.1798+03	1.2233+03	1.2272+03
63	1.2187+03	1.2069+03	1.1816+03	1.1797+03	1.2234+03	1.2272+03
64	1.2059+03	1.1950+03	1.1715+03	1.1695+03	1.2096+03	1.2134+03
65	1.2060+03	1.1952+03	1.1715+03	1.1698+03	1.2097+03	1.2135+03
66	1.2062+03	1.1954+03	1.1719+03	1.1703+03	1.2097+03	1.2136+03
67	1.3479+03	1.3017+03	1.2116+03	1.2069+03	1.4030+03	1.4107+03
68	1.3615+03	1.3091+03	1.2135+03	1.2094+03	1.4034+03	1.4120+03
69	1.3631+03	1.3098+03	1.2131+03	1.2092+03	1.4032+03	1.4124+03
70	1.3850+03	1.3355+03	1.2447+03	1.2411+03	1.4268+03	1.4306+03
71	1.3834+03	1.3340+03	1.2440+03	1.2399+03	1.4233+03	1.4289+03
72	1.3829+03	1.3337+03	1.2438+03	1.2400+03	1.4217+03	1.4268+03

CONDENSING DATA REDUCTION

	181 TC1C	183 TC2C	185 TC3C	187 TC4C	189 TC5C	191 TC6C
1	1.1982+03	1.1954+03	1.2043+03	1.1999+03	1.1546+03	1.1489+03
2	1.1982+03	1.1952+03	1.2042+03	1.1998+03	1.1546+03	1.1491+03
3	1.1982+03	1.1954+03	1.2045+03	1.2001+03	1.1549+03	1.1490+03
4	1.2921+03	1.2904+03	1.2447+03	1.2412+03	1.2427+03	1.2364+03
5	1.2921+03	1.2904+03	1.2466+03	1.2430+03	1.2426+03	1.2367+03
6	1.2921+03	1.2903+03	1.2519+03	1.2487+03	1.2426+03	1.2359+03
7	1.3981+03	1.3981+03	1.3060+03	1.3041+03	1.3343+03	1.3260+03
8	1.3981+03	1.3980+03	1.3067+03	1.3048+03	1.3345+03	1.3260+03
9	1.3978+03	1.3977+03	1.3069+03	1.3049+03	1.3342+03	1.3262+03
10	1.2989+03	1.2983+03	1.3031+03	1.3007+03	1.2379+03	1.2292+03
11	1.2990+03	1.2984+03	1.3030+03	1.3006+03	1.2377+03	1.2293+03
12	1.2990+03	1.2983+03	1.3029+03	1.3006+03	1.2376+03	1.2291+03
13	1.1984+03	1.1962+03	1.2111+03	1.2064+03	1.1388+03	1.1303+03
14	1.1984+03	1.1961+03	1.2111+03	1.2065+03	1.1392+03	1.1305+03
15	1.1984+03	1.1962+03	1.2111+03	1.2064+03	1.1390+03	1.1303+03
16	1.1975+03	1.1952+03	1.2131+03	1.2085+03	1.1234+03	1.1131+03
17	1.1975+03	1.1951+03	1.2091+03	1.2052+03	1.1234+03	1.1129+03
18	1.1978+03	1.1955+03	1.2128+03	1.2080+03	1.1232+03	1.1135+03
19	1.2919+03	1.2913+03	1.2986+03	1.2961+03	1.2167+03	1.2064+03
20	1.2918+03	1.2910+03	1.2984+03	1.2961+03	1.2166+03	1.2061+03
21	1.2922+03	1.2913+03	1.2982+03	1.2958+03	1.2169+03	1.2059+03
22	1.4191+03	1.4201+03	1.4206+03	1.4207+03	1.3472+03	1.3368+03
23	1.4191+03	1.4200+03	1.4206+03	1.4207+03	1.3469+03	1.3369+03
24	1.4190+03	1.4200+03	1.4206+03	1.4208+03	1.3471+03	1.3370+03
25	1.3933+03	1.3945+03	1.3957+03	1.3953+03	1.2990+03	1.2868+03
26	1.3932+03	1.3945+03	1.3958+03	1.3954+03	1.2986+03	1.2862+03
27	1.3932+03	1.3944+03	1.3957+03	1.3954+03	1.2988+03	1.2869+03
28	1.2635+03	1.2631+03	1.2752+03	1.2721+03	1.1701+03	1.1576+03
29	1.2638+03	1.2634+03	1.2756+03	1.2724+03	1.1700+03	1.1578+03
30	1.2639+03	1.2634+03	1.2760+03	1.2730+03	1.1702+03	1.1572+03

CONDENSING DATA REDUCTION

	181	183	185	187	189	191
	TC1C	TC2C	TC3C	TC4C	TC5C	TC6C
31	1.1924+03	1.1921+03	1.2004+03	1.1956+03	1.0886+03	1.0776+03
32	1.1917+03	1.1914+03	1.2013+03	1.1964+03	1.0887+03	1.0778+03
33	1.1916+03	1.1913+03	1.2014+03	1.1966+03	1.0891+03	1.0783+03
34	1.2884+03	1.2887+03	1.2991+03	1.2958+03	1.1716+03	1.1569+03
35	1.2883+03	1.2887+03	1.2988+03	1.2954+03	1.1717+03	1.1563+03
36	1.2887+03	1.2890+03	1.2992+03	1.2958+03	1.1718+03	1.1567+03
37	1.3995+03	1.4013+03	1.4032+03	1.4035+03	1.2838+03	1.2697+03
38	1.3998+03	1.4018+03	1.4036+03	1.4039+03	1.2840+03	1.2695+03
39	1.3998+03	1.4018+03	1.4038+03	1.4040+03	1.2838+03	1.2692+03
40	1.3971+03	1.3991+03	1.4014+03	1.4016+03	1.2671+03	1.2506+03
41	1.3969+03	1.3989+03	1.4012+03	1.4014+03	1.2672+03	1.2504+03
42	1.3971+03	1.3991+03	1.4014+03	1.4017+03	1.2674+03	1.2506+03
43	1.3392+03	1.3407+03	1.3473+03	1.3466+03	1.2081+03	1.1915+03
44	1.3381+03	1.3396+03	1.3467+03	1.3459+03	1.2078+03	1.1909+03
45	1.3372+03	1.3388+03	1.3461+03	1.3454+03	1.2077+03	1.1916+03
46	1.2582+03	1.2588+03	1.2727+03	1.2701+03	1.1413+03	1.1265+03
47	1.2579+03	1.2587+03	1.2730+03	1.2703+03	1.1412+03	1.1268+03
48	1.2583+03	1.2591+03	1.2726+03	1.2698+03	1.1411+03	1.1269+03
49	1.2488+03	1.2472+03	1.2610+03	1.2578+03	1.1672+03	1.1573+03
50	1.2490+03	1.2474+03	1.2610+03	1.2579+03	1.1672+03	1.1574+03
51	1.2488+03	1.2472+03	1.2610+03	1.2579+03	1.1674+03	1.1578+03
52	1.2368+03	1.2364+03	1.2465+03	1.2443+03	1.1671+03	1.1593+03
53	1.2364+03	1.2359+03	1.2456+03	1.2434+03	1.1666+03	1.1589+03
54	1.2366+03	1.2362+03	1.2465+03	1.2442+03	1.1669+03	1.1591+03
55	1.2288+03	1.2282+03	1.2361+03	1.2337+03	1.1726+03	1.1668+03
56	1.2291+03	1.2284+03	1.2363+03	1.2340+03	1.1728+03	1.1668+03
57	1.2289+03	1.2283+03	1.2361+03	1.2337+03	1.1727+03	1.1667+03
58	1.2275+03	1.2269+03	1.2327+03	1.2304+03	1.1803+03	1.1753+03
59	1.2277+03	1.2270+03	1.2328+03	1.2305+03	1.1804+03	1.1754+03
60	1.2277+03	1.2270+03	1.2328+03	1.2306+03	1.1804+03	1.1753+03

CONDENSING DATA REDUCTION

	181 TC1C	183 TC2C	185 TC3C	187 TC4C	189 TC5C	191 TC6C
61	1.2286+03	1.2279+03	1.2319+03	1.2297+03	1.1878+03	1.1834+03
62	1.2283+03	1.2276+03	1.2318+03	1.2296+03	1.1877+03	1.1833+03
63	1.2284+03	1.2277+03	1.2318+03	1.2296+03	1.1877+03	1.1833+03
64	1.2145+03	1.2136+03	1.2180+03	1.2155+03	1.1766+03	1.1727+03
65	1.2147+03	1.2137+03	1.2180+03	1.2155+03	1.1770+03	1.1729+03
66	1.2147+03	1.2138+03	1.2182+03	1.2157+03	1.1771+03	1.1731+03
67	1.4079+03	1.4113+03	1.4176+03	1.4176+03	1.2455+03	1.2256+03
68	1.4083+03	1.4118+03	1.4184+03	1.4195+03	1.2445+03	1.2261+03
69	1.4079+03	1.4118+03	1.4187+03	1.4200+03	1.2470+03	1.2271+03
70	1.4318+03	1.4356+03	1.4371+03	1.4387+03	1.2773+03	1.2592+03
71	1.4282+03	1.4321+03	1.4354+03	1.4369+03	1.2774+03	1.2585+03
72	1.4267+03	1.4305+03	1.4330+03	1.4350+03	1.2770+03	1.2582+03

CONDENSING DATA REDUCTION

	193 TC7C	195 TC8C	197 TC9C	199 TC10C	201 TC11C	203 TC12C
1	1.1479+03	1.1267+03	1.1266+03	1.1277+03	1.1872+03	1.1900+03
2	1.1479+03	1.1267+03	1.1267+03	1.1278+03	1.1873+03	1.1902+03
3	1.1481+03	1.1269+03	1.1268+03	1.1277+03	1.1874+03	1.1902+03
4	1.2350+03	1.2120+03	1.2117+03	1.2128+03	1.2792+03	1.2807+03
5	1.2349+03	1.2121+03	1.2118+03	1.2130+03	1.2793+03	1.2809+03
6	1.2349+03	1.2119+03	1.2117+03	1.2128+03	1.2790+03	1.2807+03
7	1.3248+03	1.2970+03	1.2965+03	1.2980+03	1.3819+03	1.3824+03
8	1.3247+03	1.2968+03	1.2965+03	1.2979+03	1.3819+03	1.3825+03
9	1.3248+03	1.2970+03	1.2965+03	1.2978+03	1.3816+03	1.3821+03
10	1.2287+03	1.1994+03	1.1987+03	1.2001+03	1.2842+03	1.2854+03
11	1.2285+03	1.1993+03	1.1987+03	1.2002+03	1.2842+03	1.2855+03
12	1.2285+03	1.1993+03	1.1988+03	1.2003+03	1.2842+03	1.2855+03
13	1.1296+03	1.0981+03	1.0974+03	1.0991+03	1.1864+03	1.1885+03
14	1.1298+03	1.0982+03	1.0976+03	1.0993+03	1.1865+03	1.1886+03
15	1.1299+03	1.0982+03	1.0976+03	1.0992+03	1.1865+03	1.1886+03
16	1.1126+03	1.0708+03	1.0697+03	1.0725+03	1.1819+03	1.1843+03
17	1.1121+03	1.0711+03	1.0698+03	1.0726+03	1.1813+03	1.1838+03
18	1.1124+03	1.0709+03	1.0697+03	1.0726+03	1.1817+03	1.1842+03
19	1.2054+03	1.1650+03	1.1637+03	1.1663+03	1.2744+03	1.2755+03
20	1.2053+03	1.1652+03	1.1640+03	1.1666+03	1.2746+03	1.2757+03
21	1.2053+03	1.1649+03	1.1637+03	1.1663+03	1.2741+03	1.2751+03
22	1.3358+03	1.2992+03	1.2981+03	1.3002+03	1.4012+03	1.4008+03
23	1.3358+03	1.2991+03	1.2981+03	1.3002+03	1.4013+03	1.4009+03
24	1.3358+03	1.2994+03	1.2982+03	1.3002+03	1.4014+03	1.4011+03
25	1.2860+03	1.2389+03	1.2374+03	1.2402+03	1.3708+03	1.3704+03
26	1.2861+03	1.2390+03	1.2374+03	1.2401+03	1.3707+03	1.3704+03
27	1.2863+03	1.2389+03	1.2373+03	1.2401+03	1.3706+03	1.3702+03
28	1.1574+03	1.1076+03	1.1061+03	1.1093+03	1.2444+03	1.2455+03
29	1.1577+03	1.1077+03	1.1061+03	1.1095+03	1.2447+03	1.2457+03
30	1.1575+03	1.1076+03	1.1059+03	1.1094+03	1.2451+03	1.2461+03

CONDENSING DATA REDUCTION

	193	195	197	199	201	203
	TC7C	TC8C	TC9C	TC10C	TC11C	TC12C
31	1.0784+03	1.0278+03	1.0253+03	1.0291+03	1.1661+03	1.1685+03
32	1.0784+03	1.0280+03	1.0254+03	1.0292+03	1.1668+03	1.1692+03
33	1.0790+03	1.0282+03	1.0257+03	1.0295+03	1.1668+03	1.1690+03
34	1.1572+03	1.0962+03	1.0942+03	1.0980+03	1.2651+03	1.2659+03
35	1.1571+03	1.0964+03	1.0943+03	1.0981+03	1.2643+03	1.2652+03
36	1.1572+03	1.0965+03	1.0942+03	1.0982+03	1.2648+03	1.2653+03
37	1.2689+03	1.2112+03	1.2092+03	1.2124+03	1.3722+03	1.3714+03
38	1.2689+03	1.2111+03	1.2090+03	1.2122+03	1.3724+03	1.3716+03
39	1.2692+03	1.2110+03	1.2091+03	1.2121+03	1.3723+03	1.3714+03
40	1.2505+03	1.1848+03	1.1828+03	1.1862+03	1.3673+03	1.3664+03
41	1.2508+03	1.1852+03	1.1831+03	1.1866+03	1.3672+03	1.3663+03
42	1.2512+03	1.1853+03	1.1835+03	1.1866+03	1.3668+03	1.3658+03
43	1.1919+03	1.1241+03	1.1224+03	1.1257+03	1.3107+03	1.3100+03
44	1.1916+03	1.1243+03	1.1225+03	1.1259+03	1.3093+03	1.3087+03
45	1.1916+03	1.1244+03	1.1226+03	1.1260+03	1.3095+03	1.3090+03
46	1.1275+03	1.0660+03	1.0641+03	1.0672+03	1.2371+03	1.2378+03
47	1.1274+03	1.0653+03	1.0637+03	1.0667+03	1.2370+03	1.2376+03
48	1.1275+03	1.0662+03	1.0644+03	1.0676+03	1.2364+03	1.2371+03
49	1.1577+03	1.1158+03	1.1141+03	1.1163+03	1.2328+03	1.2334+03
50	1.1578+03	1.1157+03	1.1142+03	1.1163+03	1.2329+03	1.2335+03
51	1.1579+03	1.1159+03	1.1143+03	1.1165+03	1.2327+03	1.2332+03
52	1.1597+03	1.1246+03	1.1234+03	1.1250+03	1.2220+03	1.2231+03
53	1.1592+03	1.1246+03	1.1234+03	1.1250+03	1.2214+03	1.2225+03
54	1.1597+03	1.1246+03	1.1234+03	1.1251+03	1.2222+03	1.2233+03
55	1.1669+03	1.1396+03	1.1386+03	1.1398+03	1.2169+03	1.2182+03
56	1.1669+03	1.1398+03	1.1388+03	1.1400+03	1.2169+03	1.2182+03
57	1.1669+03	1.1397+03	1.1387+03	1.1399+03	1.2169+03	1.2182+03
58	1.1753+03	1.1536+03	1.1528+03	1.1538+03	1.2168+03	1.2181+03
59	1.1754+03	1.1537+03	1.1529+03	1.1538+03	1.2168+03	1.2182+03
60	1.1755+03	1.1538+03	1.1529+03	1.1539+03	1.2169+03	1.2182+03

CONDENSING DATA REDUCTION

	193	195	197	199	201	203
	TC7C	TC8C	TC9C	TC10C	TC11C	TC12C
61	1.1833+03	1.1656+03	1.1648+03	1.1656+03	1.2186+03	1.2199+03
62	1.1832+03	1.1656+03	1.1649+03	1.1656+03	1.2186+03	1.2199+03
63	1.1832+03	1.1656+03	1.1649+03	1.1656+03	1.2185+03	1.2199+03
64	1.1725+03	1.1566+03	1.1559+03	1.1566+03	1.2053+03	1.2068+03
65	1.1728+03	1.1568+03	1.1561+03	1.1569+03	1.2054+03	1.2069+03
66	1.1730+03	1.1574+03	1.1566+03	1.1573+03	1.2055+03	1.2070+03
67	1.2261+03	1.1458+03	1.1436+03	1.1476+03	1.3638+03	1.3613+03
68	1.2257+03	1.1464+03	1.1442+03	1.1481+03	1.3719+03	1.3708+03
69	1.2274+03	1.1456+03	1.1433+03	1.1471+03	1.3730+03	1.3721+03
70	1.2586+03	1.1809+03	1.1785+03	1.1824+03	1.3972+03	1.3957+03
71	1.2584+03	1.1803+03	1.1782+03	1.1822+03	1.3943+03	1.3931+03
72	1.2583+03	1.1809+03	1.1783+03	1.1824+03	1.3939+03	1.3928+03

CONDENSING DATA REDUCTION

	205 TC13C	207 TC14C	209 TC15C	211 TC16C	213 TC17C	215 TC18C
1	1.1798+03	1.1610+03	1.1558+03	1.1807+03	1.1889+03	1.1713+03
2	1.1799+03	1.1611+03	1.1560+03	1.1809+03	1.1889+03	1.1713+03
3	1.1799+03	1.1608+03	1.1559+03	1.1806+03	1.1888+03	1.1713+03
4	1.2697+03	1.2490+03	1.2450+03	1.2715+03	1.2785+03	1.2608+03
5	1.2698+03	1.2492+03	1.2449+03	1.2714+03	1.2784+03	1.2607+03
6	1.2696+03	1.2490+03	1.2450+03	1.2715+03	1.2784+03	1.2607+03
7	1.3687+03	1.3428+03	1.3385+03	1.3713+03	1.3787+03	1.3577+03
8	1.3687+03	1.3428+03	1.3386+03	1.3716+03	1.3790+03	1.3579+03
9	1.3683+03	1.3426+03	1.3383+03	1.3712+03	1.3787+03	1.3577+03
10	1.2716+03	1.2457+03	1.2403+03	1.2736+03	1.2827+03	1.2612+03
11	1.2716+03	1.2460+03	1.2404+03	1.2737+03	1.2827+03	1.2613+03
12	1.2717+03	1.2461+03	1.2406+03	1.2738+03	1.2828+03	1.2613+03
13	1.1738+03	1.1473+03	1.1402+03	1.1774+03	1.1886+03	1.1640+03
14	1.1740+03	1.1475+03	1.1404+03	1.1774+03	1.1887+03	1.1640+03
15	1.1739+03	1.1474+03	1.1404+03	1.1775+03	1.1886+03	1.1640+03
16	1.1663+03	1.1333+03	1.1249+03	1.1707+03	1.1840+03	1.1534+03
17	1.1658+03	1.1330+03	1.1246+03	1.1701+03	1.1835+03	1.1531+03
18	1.1662+03	1.1334+03	1.1249+03	1.17C4+03	1.1838+03	1.1533+03
19	1.2583+03	1.2263+03	1.2190+03	1.2610+03	1.2723+03	1.2447+03
20	1.2584+03	1.2262+03	1.2189+03	1.2609+03	1.2722+03	1.2446+03
21	1.2583+03	1.2262+03	1.2191+03	1.2605+03	1.2718+03	1.2444+03
22	1.3855+03	1.3558+03	1.3508+03	1.3881+03	1.3970+03	1.3732+03
23	1.3856+03	1.3560+03	1.3508+03	1.3883+03	1.3971+03	1.3733+03
24	1.3857+03	1.3560+03	1.3508+03	1.3881+03	1.3971+03	1.3733+03
25	1.3495+03	1.3104+03	1.3040+03	1.3532+03	1.3646+03	1.3333+03
26	1.3494+03	1.3104+03	1.3039+03	1.3529+03	1.3644+03	1.3331+03
27	1.3493+03	1.3102+03	1.3037+03	1.3527+03	1.3641+03	1.3330+03
28	1.2230+03	1.1815+03	1.1740+03	1.2274+03	1.2416+03	1.2065+03
29	1.2232+03	1.1815+03	1.1741+03	1.2278+03	1.2420+03	1.2066+03
30	1.2236+03	1.1818+03	1.1743+03	1.2282+03	1.2425+03	1.2071+03

CONDENSING DATA REDUCTION

	205	207	209	211	213	215
	TC13C	TC14C	TC15C	TC16C	TC17C	TC18C
31	1.1438+03	1.1006+03	1.0933+03	1.1475+03	1.1630+03	1.1257+03
32	1.1445+03	1.1014+03	1.0940+03	1.1482+03	1.1639+03	1.1265+03
33	1.1445+03	1.1013+03	1.0941+03	1.1478+03	1.1633+03	1.1260+03
34	1.2373+03	1.1855+03	1.1769+03	1.2416+03	1.2578+03	1.2160+03
35	1.2365+03	1.1851+03	1.1767+03	1.2414+03	1.2576+03	1.2159+03
36	1.2371+03	1.1856+03	1.1771+03	1.2414+03	1.2576+03	1.2158+03
37	1.3453+03	1.2973+03	1.2899+03	1.3511+03	1.3642+03	1.3261+03
38	1.3453+03	1.2971+03	1.2897+03	1.3511+03	1.3644+03	1.3263+03
39	1.3454+03	1.2971+03	1.2898+03	1.3508+03	1.3640+03	1.3260+03
40	1.3364+03	1.2816+03	1.2737+03	1.3431+03	1.3579+03	1.3148+03
41	1.3365+03	1.2815+03	1.2742+03	1.3432+03	1.3580+03	1.3149+03
42	1.3363+03	1.2823+03	1.2737+03	1.3425+03	1.3574+03	1.3144+03
43	1.2796+03	1.2228+03	1.2146+03	1.2856+03	1.3015+03	1.2568+03
44	1.2784+03	1.2225+03	1.2137+03	1.2846+03	1.3007+03	1.2562+03
45	1.2782+03	1.2217+03	1.2136+03	1.2850+03	1.3010+03	1.2563+03
46	1.2080+03	1.1549+03	1.1470+03	1.2134+03	1.2301+03	1.1867+03
47	1.2082+03	1.1550+03	1.1472+03	1.2134+03	1.2300+03	1.1867+03
48	1.2077+03	1.1549+03	1.1472+03	1.2134+03	1.2299+03	1.1867+03
49	1.2124+03	1.1773+03	1.1713+03	1.2182+03	1.2310+03	1.2010+03
50	1.2124+03	1.1773+03	1.1712+03	1.2185+03	1.2313+03	1.2011+03
51	1.2124+03	1.1773+03	1.1712+03	1.2182+03	1.2311+03	1.2010+03
52	1.2059+03	1.1758+03	1.1715+03	1.2116+03	1.2217+03	1.1956+03
53	1.2053+03	1.1752+03	1.1712+03	1.2113+03	1.2213+03	1.1953+03
54	1.2060+03	1.1759+03	1.1717+03	1.2122+03	1.2223+03	1.1959+03
55	1.2041+03	1.1802+03	1.1768+03	1.2092+03	1.2174+03	1.1965+03
56	1.2042+03	1.1803+03	1.1768+03	1.2092+03	1.2174+03	1.1966+03
57	1.2041+03	1.1802+03	1.1768+03	1.2092+03	1.2174+03	1.1965+03
58	1.2065+03	1.1868+03	1.1838+03	1.2106+03	1.2173+03	1.2003+03
59	1.2065+03	1.1868+03	1.1839+03	1.2106+03	1.2173+03	1.2004+03
60	1.2066+03	1.1869+03	1.1840+03	1.2107+03	1.2174+03	1.2004+03

CONDENSING DATA REDUCTION

	205 TC13C	207 TC14C	209 TC15C	211 TC16C	213 TC17C	215 TC18C
61	1.2101+03	1.1935+03	1.1908+03	1.2135+03	1.2191+03	1.2051+03
62	1.2100+03	1.1935+03	1.1908+03	1.2135+03	1.2191+03	1.2050+03
63	1.2100+03	1.1934+03	1.1907+03	1.2135+03	1.2190+03	1.2051+03
64	1.1976+03	1.1821+03	1.1796+03	1.2009+03	1.2062+03	1.1932+03
65	1.1977+03	1.1824+03	1.1797+03	1.2010+03	1.2063+03	1.1933+03
66	1.1979+03	1.1826+03	1.1800+03	1.2012+03	1.2064+03	1.1935+03
67	1.3286+03	1.2641+03	1.2532+03	1.3322+03	1.3484+03	1.3006+03
68	1.3330+03	1.2655+03	1.2555+03	1.3443+03	1.3621+03	1.3080+03
69	1.3340+03	1.2663+03	1.2555+03	1.3454+03	1.3637+03	1.3088+03
70	1.3602+03	1.2962+03	1.2859+03	1.3689+03	1.3857+03	1.3347+03
71	1.3579+03	1.2956+03	1.2844+03	1.3672+03	1.3841+03	1.3331+03
72	1.3573+03	1.2942+03	1.2841+03	1.3668+03	1.3836+03	1.3329+03

CONDENSING DATA REDUCTION

	217	219	221	223	226	229
	TC19C	TC20C	TKICC	TKOC	TNAO	TNAI
1	1.1479+03	1.1454+03	1.1978+03	1.2021+03	1.1505+03	1.1270+03
2	1.1478+03	1.1452+03	1.1977+03	1.2020+03	1.1505+03	1.1271+03
3	1.1478+03	1.1453+03	1.1979+03	1.2023+03	1.1507+03	1.1271+03
4	1.2348+03	1.2325+03	1.2917+03	1.2430+03	1.2380+03	1.2122+03
5	1.2346+03	1.2324+03	1.2917+03	1.2448+03	1.2381+03	1.2123+03
6	1.2349+03	1.2326+03	1.2916+03	1.2503+03	1.2378+03	1.2121+03
7	1.3231+03	1.3217+03	1.3984+03	1.3051+03	1.3284+03	1.2972+03
8	1.3230+03	1.3217+03	1.3983+03	1.3057+03	1.3284+03	1.2971+03
9	1.3233+03	1.3218+03	1.3980+03	1.3059+03	1.3284+03	1.2971+03
10	1.2269+03	1.2245+03	1.2994+03	1.3019+03	1.2319+03	1.1994+03
11	1.2270+03	1.2248+03	1.2995+03	1.3018+03	1.2318+03	1.1994+03
12	1.2269+03	1.2247+03	1.2994+03	1.3017+03	1.2317+03	1.1995+03
13	1.1277+03	1.1248+03	1.1996+03	1.2088+03	1.1329+03	1.0982+03
14	1.1276+03	1.1247+03	1.1996+03	1.2088+03	1.1331+03	1.0983+03
15	1.1276+03	1.1247+03	1.1996+03	1.2087+03	1.1331+03	1.0983+03
16	1.1074+03	1.1043+03	1.2001+03	1.2108+03	1.1164+03	1.0710+03
17	1.1075+03	1.1044+03	1.2000+03	1.2071+03	1.1161+03	1.0712+03
18	1.1075+03	1.1045+03	1.2004+03	1.2104+03	1.1164+03	1.0711+03
19	1.2008+03	1.1980+03	1.2930+03	1.2973+03	1.2095+03	1.1650+03
20	1.2008+03	1.1980+03	1.2928+03	1.2973+03	1.2094+03	1.1652+03
21	1.2006+03	1.1977+03	1.2931+03	1.2970+03	1.2094+03	1.1649+03
22	1.3327+03	1.3305+03	1.4200+03	1.4206+03	1.3399+03	1.2992+03
23	1.3328+03	1.3303+03	1.4199+03	1.4206+03	1.3399+03	1.2991+03
24	1.3325+03	1.3303+03	1.4199+03	1.4207+03	1.3400+03	1.2993+03
25	1.2802+03	1.2775+03	1.3947+03	1.3955+03	1.2906+03	1.2388+03
26	1.2800+03	1.2775+03	1.3947+03	1.3956+03	1.2903+03	1.2388+03
27	1.2799+03	1.2775+03	1.3947+03	1.3955+03	1.2906+03	1.2388+03
28	1.1500+03	1.1473+03	1.2664+03	1.2737+03	1.1617+03	1.1077+03
29	1.1500+03	1.1473+03	1.2667+03	1.2740+03	1.1619+03	1.1078+03
30	1.1501+03	1.1475+03	1.2667+03	1.2745+03	1.1616+03	1.1077+03

CONDENSING DATA REDUCTION

	217	219	221	223	226	229
	TC19C	TC20C	TKICC	TKOC	TNAO	TNAI
31	1.0693+03	1.0668+03	1.1986+03	1.1980+03	1.0815+03	1.0274+03
32	1.0696+03	1.0674+03	1.1980+03	1.1989+03	1.0816+03	1.0275+03
33	1.0695+03	1.0674+03	1.1980+03	1.1990+03	1.0822+03	1.0278+03
34	1.1468+03	1.1440+03	1.2922+03	1.2975+03	1.1619+03	1.0961+03
35	1.1472+03	1.1439+03	1.2921+03	1.2971+03	1.1617+03	1.0963+03
36	1.1470+03	1.1439+03	1.2925+03	1.2975+03	1.1619+03	1.0963+03
37	1.2601+03	1.2579+03	1.4016+03	1.4034+03	1.2741+03	1.2109+03
38	1.2599+03	1.2582+03	1.4020+03	1.4037+03	1.2742+03	1.2108+03
39	1.2601+03	1.2579+03	1.4020+03	1.4039+03	1.2741+03	1.2107+03
40	1.2401+03	1.2374+03	1.3997+03	1.4015+03	1.2561+03	1.1846+03
41	1.2406+03	1.2376+03	1.3995+03	1.4013+03	1.2561+03	1.1850+03
42	1.2401+03	1.2374+03	1.3997+03	1.4015+03	1.2564+03	1.1851+03
43	1.1806+03	1.1770+03	1.3427+03	1.3470+03	1.1972+03	1.1241+03
44	1.1801+03	1.1771+03	1.3416+03	1.3463+03	1.1968+03	1.1243+03
45	1.1802+03	1.1773+03	1.3408+03	1.3458+03	1.1970+03	1.1243+03
46	1.1163+03	1.1135+03	1.2632+03	1.2714+03	1.1318+03	1.0658+03
47	1.1163+03	1.1134+03	1.2631+03	1.2716+03	1.1318+03	1.0653+03
48	1.1165+03	1.1137+03	1.2634+03	1.2712+03	1.1318+03	1.0661+03
49	1.1516+03	1.1482+03	1.2503+03	1.2594+03	1.1608+03	1.1154+03
50	1.1515+03	1.1481+03	1.2505+03	1.2595+03	1.1608+03	1.1154+03
51	1.1516+03	1.1482+03	1.2504+03	1.2594+03	1.1610+03	1.1156+03
52	1.1546+03	1.1531+03	1.2383+03	1.2454+03	1.1620+03	1.1243+03
53	1.1543+03	1.1528+03	1.2378+03	1.2445+03	1.1616+03	1.1243+03
54	1.1547+03	1.1532+03	1.2381+03	1.2453+03	1.1619+03	1.1244+03
55	1.1638+03	1.1626+03	1.2296+03	1.2349+03	1.1688+03	1.1393+03
56	1.1640+03	1.1626+03	1.2298+03	1.2351+03	1.1689+03	1.1395+03
57	1.1639+03	1.1626+03	1.2296+03	1.2349+03	1.1688+03	1.1394+03
58	1.1736+03	1.1727+03	1.2278+03	1.2315+03	1.1769+03	1.1534+03
59	1.1738+03	1.1727+03	1.2280+03	1.2316+03	1.1771+03	1.1534+03
60	1.1737+03	1.1728+03	1.2280+03	1.2317+03	1.1771+03	1.1535+03

CONDENSING DATA REDUCTION

	217 TC19C	219 TC20C	221 TKICC	223 TKOC	226 TNAO	229 TNAI
61	1.1827+03	1.1818+03	1.2286+03	1.2308+03	1.1848+03	1.1653+03
62	1.1826+03	1.1818+03	1.2284+03	1.2307+03	1.1847+03	1.1653+03
63	1.1827+03	1.1817+03	1.2284+03	1.2307+03	1.1848+03	1.1653+03
64	1.1726+03	1.1714+03	1.2144+03	1.2167+03	1.1739+03	1.1564+03
65	1.1726+03	1.1717+03	1.2146+03	1.2168+03	1.1742+03	1.1566+03
66	1.1730+03	1.1722+03	1.2146+03	1.2169+03	1.1744+03	1.1571+03
67	1.2127+03	1.2091+03	1.4118+03	1.4176+03	1.2324+03	1.1457+03
68	1.2145+03	1.2116+03	1.4122+03	1.4189+03	1.2321+03	1.1462+03
69	1.2142+03	1.2114+03	1.4121+03	1.4193+03	1.2338+03	1.1453+03
70	1.2457+03	1.2435+03	1.4353+03	1.4379+03	1.2650+03	1.1806+03
71	1.2450+03	1.2424+03	1.4318+03	1.4361+03	1.2648+03	1.1802+03
72	1.2448+03	1.2424+03	1.4303+03	1.4340+03	1.2645+03	1.1805+03

CONDENSING DATA REDUCTION

	230	235	237	238	240	243
	DTNA	WNA	TNAM	CPNA	QNA	DTQL
1	2.3498+01	4.7695+03	1.1387+03	3.0000-01	3.3622+04	1.0597+03
2	2.3455+01	4.7695+03	1.1388+03	3.0000-01	3.3561+04	1.0598+03
3	2.3527+01	4.7695+03	1.1389+03	3.0000-01	3.3664+04	1.0599+03
4	2.5879+01	4.6131+03	1.2251+03	3.0013-01	3.5829+04	1.1470+03
5	2.5779+01	4.6131+03	1.2252+03	3.0013-01	3.5691+04	1.1466+03
6	2.5679+01	4.6131+03	1.2250+03	3.0012-01	3.5552+04	1.1468+03
7	3.1170+01	4.6254+03	1.3128+03	3.0069-01	4.3352+04	1.2347+03
8	3.1313+01	4.6254+03	1.3127+03	3.0069-01	4.3551+04	1.2346+03
9	3.1298+01	4.6254+03	1.3128+03	3.0069-01	4.3531+04	1.2347+03
10	3.2543+01	4.7176+03	1.2157+03	3.0008-01	4.6069+04	1.1313+03
11	3.2442+01	4.7176+03	1.2156+03	3.0008-01	4.5926+04	1.1313+03
12	3.2242+01	4.7176+03	1.2156+03	3.0008-01	4.5643+04	1.1312+03
13	3.4683+01	4.6515+03	1.1155+03	3.0000-01	4.8398+04	1.0307+03
14	3.4798+01	4.6515+03	1.1157+03	3.0000-01	4.8560+04	1.0314+03
15	3.4770+01	4.6515+03	1.1157+03	3.0000-01	4.8520+04	1.0313+03
16	4.5372+01	4.4159+03	1.0937+03	3.0005-01	6.0117+04	1.0111+03
17	4.4977+01	4.4159+03	1.0937+03	3.0005-01	5.9594+04	1.0111+03
18	4.5301+01	4.4159+03	1.0937+03	3.0005-01	6.0024+04	1.0116+03
19	4.4528+01	4.4353+03	1.1872+03	3.0000-01	5.9249+04	1.1020+03
20	4.4114+01	4.4353+03	1.1873+03	3.0000-01	5.8699+04	1.1020+03
21	4.4442+01	4.4353+03	1.1872+03	3.0000-01	5.9135+04	1.1019+03
22	4.0776+01	4.3160+03	1.3195+03	3.0079-01	5.2937+04	1.2294+03
23	4.0733+01	4.3160+03	1.3195+03	3.0079-01	5.2881+04	1.2289+03
24	4.0719+01	4.3160+03	1.3196+03	3.0079-01	5.2863+04	1.2294+03
25	5.1790+01	4.6033+03	1.2647+03	3.0032-01	7.1599+04	1.1768+03
26	5.1447+01	4.6033+03	1.2646+03	3.0032-01	7.1125+04	1.1766+03
27	5.1876+01	4.6033+03	1.2647+03	3.0032-01	7.1718+04	1.1763+03
28	5.4055+01	4.6114+03	1.1347+03	3.0000-01	7.4780+04	1.0508+03
29	5.4113+01	4.6114+03	1.1348+03	3.0000-01	7.4860+04	1.0509+03
30	5.3955+01	4.6114+03	1.1346+03	3.0000-01	7.4642+04	1.0512+03

CONDENSING DATA REDUCTION

	230	235	237	238	240	243
	DTNA	WNA	TNAM	CPNA	QNA	DTQL
31	5.4123+01	4.6244+03	1.0545+03	3.0036-01	7.5177+04	9.6295+02
32	5.4108+01	4.6244+03	1.0546+03	3.0036-01	7.5156+04	9.6307+02
33	5.4376+01	4.6244+03	1.0550+03	3.0036-01	7.5527+04	9.6345+02
34	6.5788+01	4.6258+03	1.1290+03	3.0000-01	9.1296+04	1.0460+03
35	6.5420+01	4.6258+03	1.1290+03	3.0000-01	9.0786+04	1.0464+03
36	6.5620+01	4.6258+03	1.1291+03	3.0000-01	9.1064+04	1.0461+03
37	6.3163+01	4.5665+03	1.2425+03	3.0021-01	8.6591+04	1.1599+03
38	6.3391+01	4.5665+03	1.2425+03	3.0021-01	8.6904+04	1.1599+03
39	6.3349+01	4.5665+03	1.2424+03	3.0021-01	8.6846+04	1.1598+03
40	7.1436+01	4.5676+03	1.2203+03	3.0010-01	9.7922+04	1.1386+03
41	7.1153+01	4.5676+03	1.2205+03	3.0010-01	9.7534+04	1.1389+03
42	7.1269+01	4.5676+03	1.2207+03	3.0010-01	9.7693+04	1.1391+03
43	7.3139+01	4.5693+03	1.1606+03	3.0000-01	1.0026+05	1.0821+03
44	7.2512+01	4.5693+03	1.1605+03	3.0000-01	9.9398+04	1.0819+03
45	7.2656+01	4.5693+03	1.1607+03	3.0000-01	9.9595+04	1.0821+03
46	6.6008+01	4.6431+03	1.0988+03	3.0001-01	9.1947+04	1.9411+02
47	6.6540+01	4.6431+03	1.0985+03	3.0001-01	9.2688+04	1.9387+02
48	6.5742+01	4.6431+03	1.0989+03	3.0001-01	9.1576+04	1.9428+02
49	4.5359+01	4.6942+03	1.1381+03	3.0000-01	6.3876+04	2.3342+02
50	4.5388+01	4.6942+03	1.1381+03	3.0000-01	6.3917+04	2.3345+02
51	4.5461+01	4.6942+03	1.1383+03	3.0000-01	6.4020+04	2.3363+02
52	3.7722+01	4.6776+03	1.1432+03	3.0000-01	5.2935+04	2.3852+02
53	3.7236+01	4.6776+03	1.1429+03	3.0000-01	5.2253+04	2.3828+02
54	3.7565+01	4.6776+03	1.1431+03	3.0000-01	5.2715+04	2.3847+02
55	2.9449+01	4.6791+03	1.1541+03	3.0000-01	4.1338+04	2.4939+02
56	2.9323+01	4.6791+03	1.1542+03	3.0000-01	4.1162+04	2.4953+02
57	2.9308+01	4.6791+03	1.1541+03	3.0000-01	4.1140+04	2.4944+02
58	2.3543+01	4.6799+03	1.1652+03	3.0000-01	3.3054+04	2.6050+02
59	2.3644+01	4.6799+03	1.1653+03	3.0000-01	3.3195+04	2.6061+02
60	2.3530+01	4.6799+03	1.1653+03	3.0000-01	3.3036+04	2.6064+02

CONDENSING DATA REDUCTION

	230	235	237	238	240	243
	DTNA	WNA	TNAM	CPNA	QNA	DTQL
61	1.9484+01	4.6834+03	1.1751+03	3.0000-01	2.7376+04	2.7040+02
62	1.9398+01	4.6834+03	1.1750+03	3.0000-01	2.7255+04	2.7038+02
63	1.9413+01	4.6834+03	1.1750+03	3.0000-01	2.7275+04	2.7038+02
64	1.7543+01	4.6988+03	1.1652+03	3.0000-01	2.4729+04	2.6051+02
65	1.7630+01	4.6988+03	1.1654+03	3.0000-01	2.4853+04	2.6076+02
66	1.7304+01	4.6988+03	1.1657+03	3.0000-01	2.4393+04	2.6109+02
67	8.6698+01	4.6445+03	1.1890+03	3.0000-01	1.2080+05	7.3367+01
68	8.5888+01	4.6445+03	1.1892+03	3.0000-01	1.1967+05	7.3484+01
69	8.8499+01	4.6445+03	1.1896+03	3.0000-01	1.2331+05	7.3901+01
70	8.4440+01	4.5836+03	1.2228+03	3.0011-01	1.1616+05	1.0714+02
71	8.4524+01	4.5836+03	1.2225+03	3.0011-01	1.1627+05	1.0683+02
72	8.3982+01	4.5836+03	1.2225+03	3.0011-01	1.1553+05	1.0684+02

CONDENSING DATA REDUCTION

	246	247	251	306	317	319
	QC	Q/AA	WK	TWI T	Q/A T	TWO T
1	3.6168+04	7.3453+04	4.1734+01	1.1951+03	6.8350+04	1.1438+03
2	3.6108+04	7.3331+04	4.1664+01	1.1953+03	6.8483+04	1.1439+03
3	3.6212+04	7.3541+04	4.1785+01	1.1954+03	6.8911+04	1.1437+03
4	3.8723+04	7.8641+04	4.5167+01	1.2868+03	7.6247+04	1.2308+03
5	3.8583+04	7.8356+04	4.5010+01	1.2870+03	7.6299+04	1.2309+03
6	3.8444+04	7.8076+04	4.4868+01	1.2866+03	7.5899+04	1.2309+03
7	4.6611+04	9.4661+04	5.5157+01	1.3915+03	9.6579+04	1.3221+03
8	4.6809+04	9.5062+04	5.5394+01	1.3915+03	9.6533+04	1.3221+03
9	4.6789+04	9.5023+04	5.5371+01	1.3911+03	9.6381+04	1.3218+03
10	4.8899+04	9.9307+04	5.7344+01	1.2948+03	9.4060+04	1.2257+03
11	4.8756+04	9.9017+04	5.7177+01	1.2947+03	9.3655+04	1.2259+03
12	4.8473+04	9.8442+04	5.6844+01	1.2948+03	9.3529+04	1.2261+03
13	5.0834+04	1.0324+05	5.8696+01	1.1987+03	9.4783+04	1.1275+03
14	5.0998+04	1.0357+05	5.8885+01	1.1988+03	9.4623+04	1.1277+03
15	5.0958+04	1.0349+05	5.8839+01	1.1989+03	9.4788+04	1.1277+03
16	6.2478+04	1.2688+05	7.2156+01	1.1982+03	1.1483+05	1.1118+03
17	6.1955+04	1.2582+05	7.1530+01	1.1976+03	1.1451+05	1.1114+03
18	6.2387+04	1.2670+05	7.2050+01	1.1980+03	1.1443+05	1.1118+03
19	6.1961+04	1.2584+05	7.2598+01	1.2888+03	1.1470+05	1.2043+03
20	6.1411+04	1.2472+05	7.1952+01	1.2891+03	1.1535+05	1.2041+03
21	6.1847+04	1.2560+05	7.2463+01	1.2884+03	1.1411+05	1.2043+03
22	5.6173+04	1.1408+05	6.7309+01	1.4124+03	1.0982+05	1.3338+03
23	5.6114+04	1.1396+05	6.7239+01	1.4125+03	1.0991+05	1.3339+03
24	5.6099+04	1.1393+05	6.7221+01	1.4127+03	1.1015+05	1.3338+03
25	7.4615+04	1.5153+05	8.8982+01	1.3877+03	1.4069+05	1.2861+03
26	7.4140+04	1.5057+05	8.8416+01	1.3877+03	1.4068+05	1.2861+03
27	7.4731+04	1.5177+05	8.9121+01	1.3876+03	1.4081+05	1.2859+03
28	7.7292+04	1.5697+05	9.0193+01	1.2643+03	1.4315+05	1.1579+03
29	7.7373+04	1.5713+05	9.0292+01	1.2646+03	1.4345+05	1.1580+03
30	7.7156+04	1.5669+05	9.0042+01	1.2651+03	1.4394+05	1.1581+03

CONDENSING DATA REDUCTION

	246	247	251	306	317	319
	QC	Q/AA	WK	TWI T	Q/A T	TWO T
31	7.7359+04	1.5711+05	8.9242+01	1.1881+03	1.4586+05	1.0777+03
32	7.7339+04	1.5706+05	8.9221+01	1.1888+03	1.4594+05	1.0784+03
33	7.7711+04	1.5782+05	8.9651+01	1.1887+03	1.4577+05	1.0784+03
34	9.3790+04	1.9048+05	1.0988+02	1.2908+03	1.7783+05	1.1590+03
35	9.3281+04	1.8944+05	1.0928+02	1.2898+03	1.7692+05	1.1587+03
36	9.3558+04	1.9001+05	1.0962+02	1.2902+03	1.7671+05	1.1592+03
37	8.9537+04	1.8184+05	1.0692+02	1.3942+03	1.7081+05	1.2707+03
38	8.9850+04	1.8247+05	1.0730+02	1.3945+03	1.7157+05	1.2704+03
39	8.9792+04	1.8236+05	1.0724+02	1.3943+03	1.7118+05	1.2705+03
40	1.0078+05	2.0467+05	1.2031+02	1.3932+03	1.9278+05	1.2535+03
41	1.0039+05	2.0389+05	1.1984+02	1.3930+03	1.9222+05	1.2537+03
42	1.0055+05	2.0421+05	1.2004+02	1.3923+03	1.9092+05	1.2539+03
43	1.0289+05	2.0896+05	1.2161+02	1.3380+03	1.9475+05	1.1950+03
44	1.0203+05	2.0721+05	1.2057+02	1.3364+03	1.9320+05	1.1944+03
45	1.0223+05	2.0761+05	1.2079+02	1.3368+03	1.9452+05	1.1939+03
46	9.2112+04	1.8707+05	1.0744+02	1.2636+03	1.8072+05	1.1287+03
47	9.2852+04	1.8857+05	1.0830+02	1.2633+03	1.8011+05	1.1289+03
48	9.1741+04	1.8631+05	1.0701+02	1.2626+03	1.7906+05	1.1290+03
49	6.4098+04	1.3018+05	7.4615+01	1.2491+03	1.2584+05	1.1554+03
50	6.4139+04	1.3026+05	7.4664+01	1.2492+03	1.2600+05	1.1554+03
51	6.4242+04	1.3047+05	7.4783+01	1.2489+03	1.2553+05	1.1554+03
52	5.3165+04	1.0797+05	6.1759+01	1.2352+03	1.0591+05	1.1562+03
53	5.2482+04	1.0658+05	6.0959+01	1.2346+03	1.0575+05	1.1557+03
54	5.2944+04	1.0752+05	6.1501+01	1.2354+03	1.0611+05	1.1563+03
55	4.1585+04	8.4454+04	4.8233+01	1.2266+03	8.6327+04	1.1622+03
56	4.1409+04	8.4096+04	4.8030+01	1.2266+03	8.6163+04	1.1623+03
57	4.1387+04	8.4051+04	4.8003+01	1.2266+03	8.6327+04	1.1622+03
58	3.3319+04	6.7666+04	3.8629+01	1.2240+03	7.2561+04	1.1699+03
59	3.3461+04	6.7954+04	3.8794+01	1.2241+03	7.2683+04	1.1699+03
60	3.3301+04	6.7630+04	3.8609+01	1.2242+03	7.2661+04	1.1700+03

CONDENSING DATA REDUCTION

	246	247	251	306	317	319
	QC	Q/AA	WK	TWI T	Q/A T	TWO T
61	2.7657+04	5.6168+04	3.2065+01	1.2241+03	6.2822+04	1.1773+03
62	2.7536+04	5.5922+04	3.1924+01	1.2240+03	6.2721+04	1.1773+03
63	2.7556+04	5.5963+04	3.1947+01	1.2240+03	6.2730+04	1.1773+03
64	2.4994+04	5.0760+04	2.8912+01	1.2102+03	5.8613+04	1.1665+03
65	2.5118+04	5.1012+04	2.9056+01	1.2104+03	5.8534+04	1.1666+03
66	2.4659+04	5.0078+04	2.8525+01	1.2104+03	5.8152+04	1.1670+03
67	1.2083+05	2.4540+05	1.4463+02	1.3946+03	2.2238+05	1.2329+03
68	1.1971+05	2.4311+05	1.4331+02	1.4053+03	2.3673+05	1.2335+03
69	1.2334+05	2.5050+05	1.4767+02	1.4068+03	2.3841+05	1.2338+03
70	1.1622+05	2.3603+05	1.3970+02	1.4284+03	2.2746+05	1.2644+03
71	1.1633+05	2.3626+05	1.3977+02	1.4250+03	2.2373+05	1.2636+03
72	1.1559+05	2.3475+05	1.3882+02	1.4248+03	2.2465+05	1.2627+03

CONDENSING DATA REDUCTION

	324 HCON T	326 NUC T	354 TWI B	365 Q/A B	367 TWO B	372 HCON B
1	-4.6108+04	-1.2943-01	1.1955+03	7.2451+04	1.1412+03	3.4481+04
2	-3.8299+04	-1.0751-01	1.1958+03	7.3007+04	1.1410+03	4.1188+04
3	-3.9274+04	-1.1025-01	1.1955+03	7.2508+04	1.1411+03	3.1652+04
4	-8.7739+03	-2.4989-02	1.2858+03	7.9005+04	1.2277+03	-2.1853+03
5	-8.9851+03	-2.5592-02	1.2857+03	7.9046+04	1.2275+03	-2.2827+03
6	-1.0346+04	-2.9472-02	1.2856+03	7.8604+04	1.2278+03	-2.5846+03
7	-6.4017+03	-1.8542-02	1.3888+03	1.0294+05	1.3148+03	-1.5066+03
8	-6.4167+03	-1.8586-02	1.3893+03	1.0367+05	1.3147+03	-1.5183+03
9	-6.4801+03	-1.8769-02	1.3887+03	1.0253+05	1.3150+03	-1.5153+03
10	-9.8935+04	-2.8255-01	1.2934+03	1.0204+05	1.2184+03	3.6315+04
11	-1.1448+05	-3.2695-01	1.2935+03	1.0182+05	1.2186+03	3.7262+04
12	-1.0037+05	-2.8666-01	1.2936+03	1.0216+05	1.2184+03	4.0904+04
13	-2.6202+04	-7.3565-02	1.2013+03	1.1017+05	1.1184+03	6.9538+04
14	-2.5217+04	-7.0801-02	1.2013+03	1.1042+05	1.1183+03	7.3910+04
15	-2.5278+04	-7.0971-02	1.2014+03	1.1043+05	1.1183+03	7.5488+04
16	-3.2555+04	-9.1397-02	1.2014+03	1.3949+05	1.0962+03	4.8969+04
17	-3.1693+04	-8.8974-02	1.2006+03	1.3832+05	1.0963+03	1.8928+05
18	-3.6918+04	-1.0365-01	1.2010+03	1.3884+05	1.0963+03	4.7804+04
19	-7.5043+04	-2.1407-01	1.2878+03	1.3222+05	1.1902+03	3.9209+04
20	-5.8725+04	-1.6752-01	1.2877+03	1.3216+05	1.1901+03	3.8968+04
21	-1.0971+05	-3.1296-01	1.2873+03	1.3183+05	1.1899+03	3.6169+04
22	1.7160+05	5.0081-01	1.4096+03	1.2072+05	1.3230+03	3.0602+04
23	2.4494+05	7.1485-01	1.4098+03	1.2117+05	1.3229+03	3.2900+04
24	4.2474+05	1.2396+00	1.4097+03	1.2128+05	1.3228+03	3.1834+04
25	-2.6889+06	-7.8031+00	1.3839+03	1.6022+05	1.2678+03	3.3521+04
26	-8.2027+06	-2.3804+01	1.3835+03	1.5985+05	1.2678+03	3.0940+04
27	2.4887+06	7.2221+00	1.3833+03	1.5958+05	1.2677+03	2.9808+04
28	-3.4391+04	-9.7638-02	1.2635+03	1.6966+05	1.1370+03	5.0063+04
29	-3.4412+04	-9.7703-02	1.2640+03	1.7035+05	1.1370+03	5.2287+04
30	-3.1413+04	-8.9190-02	1.2646+03	1.7103+05	1.1371+03	5.6135+04

CONDENSING DATA REDUCTION

	324	326	354	365	367	372
	HCON T	NUC T	TWI B	Q/A B	TWO B	HCON B
31	1.3874+05	3.8930-01	1.1857+03	1.7049+05	1.0562+03	2.1856+04
32	-2.2310+06	-6.2598+00	1.1867+03	1.7127+05	1.0566+03	2.3352+04
33	-2.9476+06	-8.2705+00	1.1859+03	1.7029+05	1.0566+03	2.0979+04
34	-2.9808+04	-8.4995-02	1.2858+03	2.0741+05	1.1314+03	4.2821+04
35	-3.4472+04	-9.8292-02	1.2854+03	2.0667+05	1.1316+03	4.2034+04
36	-3.4672+04	-9.8867-02	1.2855+03	2.0692+05	1.1314+03	3.9375+04
37	9.8223+05	2.8536+00	1.3899+03	1.9877+05	1.2456+03	3.2343+04
38	7.2109+05	2.0951+00	1.3901+03	1.9901+05	1.2456+03	3.1406+04
39	3.6542+05	1.0617+00	1.3896+03	1.9841+05	1.2456+03	2.8649+04
40	-1.8694+05	-5.4292-01	1.3881+03	2.2577+05	1.2237+03	3.7076+04
41	-1.8045+05	-5.2404-01	1.3881+03	2.2527+05	1.2240+03	3.8303+04
42	-1.1101+06	-3.2240+00	1.3873+03	2.2458+05	1.2237+03	3.2771+04
43	-7.0474+04	-2.0270-01	1.3332+03	2.3003+05	1.1634+03	3.5014+04
44	-9.2718+04	-2.6664-01	1.3320+03	2.2864+05	1.1633+03	3.3042+04
45	-5.8246+04	-1.6748-01	1.3324+03	2.2906+05	1.1634+03	3.8362+04
46	-2.3176+04	-6.5748-02	1.2591+03	2.1160+05	1.1005+03	4.2272+04
47	-2.3471+04	-6.6583-02	1.2591+03	2.1161+05	1.1005+03	4.1056+04
48	-2.6935+04	-7.6414-02	1.2589+03	2.1112+05	1.1007+03	4.1562+04
49	-3.2571+04	-9.2227-02	1.2496+03	1.4709+05	1.1398+03	4.8167+04
50	-3.3129+04	-9.3812-02	1.2500+03	1.4782+05	1.1397+03	5.3476+04
51	-3.4196+04	-9.6830-02	1.2496+03	1.4708+05	1.1398+03	4.8130+04
52	-6.2773+04	-1.7738-01	1.2368+03	1.2267+05	1.1452+03	4.5552+04
53	-6.7041+04	-1.8942-01	1.2364+03	1.2254+05	1.1448+03	5.3964+04
54	-5.0312+04	-1.4216-01	1.2375+03	1.2358+05	1.1452+03	6.7332+04
55	-5.7358+04	-1.6184-01	1.2285+03	9.6819+04	1.1562+03	8.1527+04
56	-6.6548+04	-1.8777-01	1.2285+03	9.6695+04	1.1563+03	7.0215+04
57	-6.0963+04	-1.7201-01	1.2285+03	9.6816+04	1.1562+03	8.0971+04
58	-1.3521+05	-3.8140-01	1.2255+03	7.7923+04	1.1674+03	6.0015+04
59	-1.5249+05	-4.3014-01	1.2255+03	7.7840+04	1.1675+03	5.7539+04
60	-1.4193+05	-4.0035-01	1.2256+03	7.8018+04	1.1675+03	5.8908+04

CONDENSING DATA REDUCTION

	324 HCON T	326 NUC T	354 TWI B	365 Q/A B	367 TWO B	372 HCON B
61	5.1496+05	1.4528+00	1.2252+03	6.4267+04	1.1774+03	5.2210+04
62	-2.1331+06	-6.0174+00	1.2252+03	6.4266+04	1.1773+03	5.7780+04
63	1.7215+06	4.8565+00	1.2252+03	6.4319+04	1.1773+03	5.8488+04
64	-1.8248+06	-5.1353+00	1.2117+03	5.9212+04	1.1675+03	6.4630+04
65	-2.2971+07	-6.4643+01	1.2118+03	5.9168+04	1.1676+03	6.9379+04
66	2.9048+06	8.1746+00	1.2119+03	5.8652+04	1.1681+03	6.3872+04
67	2.2944+04	6.6799-02	1.3855+03	2.6219+05	1.1937+03	1.1162+04
68	-4.8091+05	-1.4004+00	1.4018+03	2.8427+05	1.1943+03	3.4274+04
69	-1.1427+05	-3.3274-01	1.4038+03	2.8780+05	1.1937+03	4.3857+04
70	-2.2915+05	-6.7146-01	1.4227+03	2.7014+05	1.2267+03	3.8037+04
71	-2.8220+05	-8.2618-01	1.4207+03	2.6852+05	1.2259+03	3.8684+04
72	-1.0048+05	-2.9404-01	1.4201+03	2.6774+05	1.2259+03	4.8677+04

CONDENSING DATA REDUCTION

	374	389	399	401	405	406
	NUC B	TWI TC	Q/A TC	TWO TC	TKC-TW	HCONTC
1	9.6834-02	1.2001+03	6.0943+04	1.1545+03	-1.5657+00	-3.8924+04
2	1.1567-01	1.2003+03	6.1076+04	1.1546+03	-1.8768+00	-3.2543+04
3	8.8892-02	1.2004+03	6.1508+04	1.1544+03	-1.8371+00	-3.3482+04
4	-6.1928-03	1.2924+03	6.7861+04	1.2426+03	-8.7959+00	-7.7151+03
5	-6.4703-03	1.2925+03	6.7912+04	1.2427+03	-8.5947+00	-7.9016+03
6	-7.3316-03	1.2922+03	6.7507+04	1.2427+03	-7.4225+00	-9.0949+03
7	-4.3226-03	1.3976+03	8.7264+04	1.3351+03	-1.4805+01	-5.8941+03
8	-4.3564-03	1.3976+03	8.7214+04	1.3351+03	-1.4759+01	-5.9092+03
9	-4.3479-03	1.3972+03	8.7065+04	1.3348+03	-1.4587+01	-5.9685+03
10	1.0376-01	1.3005+03	8.5936+04	1.2374+03	-6.5471-01	-1.3126+05
11	1.0646-01	1.3004+03	8.5524+04	1.2377+03	-5.2490-01	-1.6293+05
12	1.1686-01	1.3004+03	8.5395+04	1.2378+03	-6.4775-01	-1.3183+05
13	1.9543-01	1.2038+03	8.7865+04	1.1380+03	2.7017+00	-3.2522+04
14	2.0772-01	1.2039+03	8.7702+04	1.1382+03	-2.8216+00	-3.1082+04
15	2.1215-01	1.2040+03	8.7868+04	1.1381+03	-2.8237+00	-3.1118+04
16	1.3766-01	1.2034+03	1.0830+05	1.1220+03	-1.4399+00	-7.5217+04
17	5.3182-01	1.2028+03	1.0798+05	1.1216+03	-1.5931+00	-6.7782+04
18	1.3437-01	1.2031+03	1.0791+05	1.1220+03	-1.0316+00	-1.0460+05
19	1.1193-01	1.2945+03	1.0707+05	1.2157+03	-7.9288-01	-1.3504+05
20	1.1124-01	1.2948+03	1.0773+05	1.2155+03	-1.2559+00	-8.5779+04
21	1.0325-01	1.2941+03	1.0648+05	1.2157+03	-3.0940-01	-3.4414+05
22	8.9326-02	1.4187+03	1.0051+05	1.3469+03	1.3898+00	7.2319+04
23	9.6032-02	1.4188+03	1.0060+05	1.3470+03	1.1966+00	8.4075+04
24	9.2921-02	1.4190+03	1.0085+05	1.3470+03	1.0064+00	1.0020+05
25	9.7294-02	1.3940+03	1.3233+05	1.2986+03	8.5715-01	1.5438+05
26	8.9802-02	1.3939+03	1.3232+05	1.2986+03	8.8387-01	1.4971+05
27	8.6515-02	1.3938+03	1.3245+05	1.2984+03	9.6922-01	1.3666+05
28	1.4230-01	1.2699+03	1.3637+05	1.1687+03	-2.3058+00	-5.9142+04
29	1.4863-01	1.2702+03	1.3668+05	1.1688+03	-2.3125+00	-5.9105+04
30	1.5958-01	1.2707+03	1.3717+05	1.1690+03	-2.7446+00	-4.9978+04

CONDENSING DATA REDUCTION

	374	389	399	401	405	406
	NUC B	TWI TC	Q/A TC	TWO TC	TKC-TW	HCONTC
31	6.1352-02	1.1933+03	1.4004+05	1.0874+03	5.2753+00	2.6546+04
32	6.5556-02	1.1940+03	1.4011+05	1.0881+03	4.1898+00	3.3440+04
33	5.8896-02	1.1939+03	1.3994+05	1.0882+03	4.2719+00	3.2758+04
34	1.2222-01	1.2966+03	1.7141+05	1.1698+03	-3.5116+00	-4.8812+04
35	1.1997-01	1.2957+03	1.7048+05	1.1695+03	-2.7059+00	-6.3004+04
36	1.1239-01	1.2960+03	1.7027+05	1.1700+03	-2.6602+00	-6.4006+04
37	9.3990-02	1.4005+03	1.6298+05	1.2830+03	1.3616+00	1.1970+05
38	9.1274-02	1.4009+03	1.6374+05	1.2827+03	1.4324+00	1.1431+05
39	8.3263-02	1.4007+03	1.6335+05	1.2828+03	1.6629+00	9.8235+04
40	1.0771-01	1.3996+03	1.8539+05	1.2655+03	4.1582-01	4.4585+05
41	1.1127-01	1.3994+03	1.8482+05	1.2657+03	3.7315-01	4.9530+05
42	9.5205-02	1.3987+03	1.8352+05	1.2660+03	1.2742+00	1.4402+05
43	1.0079-01	1.3442+03	1.8807+05	1.2063+03	-7.2658-01	-2.5885+05
44	9.5099-02	1.3425+03	1.8652+05	1.2057+03	-6.6818-02	-2.7914+06
45	1.1040-01	1.3429+03	1.8786+05	1.2052+03	-1.3064+00	-1.4380+05
46	1.2010-01	1.2692+03	1.7468+05	1.1391+03	-4.6596+00	-3.7487+04
47	1.1664-01	1.2690+03	1.7406+05	1.1394+03	-4.4557+00	-3.9065+04
48	1.1808-01	1.2683+03	1.7300+05	1.1394+03	-3.5427+00	-4.8831+04
49	1.3657-01	1.2545+03	1.1891+05	1.1662+03	-2.6921+00	-4.4169+04
50	1.5162-01	1.2547+03	1.1907+05	1.1662+03	-2.6318+00	-4.5243+04
51	1.3647-01	1.2544+03	1.1860+05	1.1662+03	-2.4878+00	-4.7671+04
52	1.2885-01	1.2405+03	9.8742+04	1.1670+03	-1.0351+00	-9.5390+04
53	1.5263-01	1.2399+03	9.8588+04	1.1665+03	-9.6381-01	-1.0229+05
54	1.9046-01	1.2407+03	9.8947+04	1.1671+03	-1.4708+00	-6.7274+04
55	2.3022-01	1.2319+03	7.8883+04	1.1731+03	-1.4133+00	-5.5813+04
56	1.9828-01	1.2319+03	7.8715+04	1.1733+03	-1.2108+00	-6.5013+04
57	2.2865-01	1.2319+03	7.8882+04	1.1731+03	-1.3342+00	-5.9122+04
58	1.6939-01	1.2292+03	6.4881+04	1.1809+03	-7.7228-01	-8.4013+04
59	1.6240-01	1.2293+03	6.5003+04	1.1809+03	-7.0610-01	-9.2059+04
60	1.6627-01	1.2294+03	6.4980+04	1.1810+03	-7.4727-01	-8.6956+04

CONDENSING DATA REDUCTION

	374	389	399	401	405	406
	NUC B	TWI TC	Q/A TC	TWO TC	TKC-TW	HCONTC
61	1.4735-01	1.2293+03	5.4952+04	1.1884+03	-2.7708-01	-1.9832+05
62	1.6306-01	1.2292+03	5.4851+04	1.1884+03	-4.3402-01	-1.2638+05
63	1.6506-01	1.2291+03	5.4859+04	1.1884+03	-3.6635-01	-1.4975+05
64	1.8195-01	1.2153+03	5.0831+04	1.1774+03	-5.5008-01	-9.2407+04
65	1.9533-01	1.2154+03	5.0749+04	1.1776+03	-5.1651-01	-9.8254+04
66	1.7982-01	1.2155+03	5.0360+04	1.1779+03	-5.0574-01	-9.9577+04
67	3.2540-02	1.4011+03	2.1561+05	1.2447+03	1.1692+01	1.8440+04
68	9.9948-02	1.4119+03	2.3007+05	1.2453+03	1.3981+00	1.6456+05
69	1.2790-01	1.4134+03	2.3176+05	1.2456+03	-8.1116-02	-2.8572+06
70	1.1153-01	1.4351+03	2.2033+05	1.2766+03	6.5974-01	3.3396+05
71	1.1336-01	1.4317+03	2.1657+05	1.2758+03	8.9500-01	2.4197+05
72	1.4256-01	1.4315+03	2.1751+05	1.2749+03	-5.6947-01	-3.8194+05

CONDENSING DATA REDUCTION

	408	424	434	436	439	440
	NUC TC	TWI BC	Q/A BC	TWO BC	TK-TWI	HCONBC
1	-1.0932-01	1.1994+03	7.7356+04	1.1414+03	1.7383+00	4.4501+04
2	-9.1398-02	1.1997+03	7.7918+04	1.1412+03	1.4041+00	5.5492+04
3	-9.4037-02	1.1994+03	7.7412+04	1.1413+03	1.9329+00	4.0050+04
4	-2.1994-02	1.2910+03	8.5673+04	1.2280+03	-3.7201+01	-2.3029+03
5	-2.2527-02	1.2909+03	8.5711+04	1.2279+03	-3.5651+01	-2.4042+03
6	-2.5933-02	1.2908+03	8.5270+04	1.2282+03	-3.1357+01	-2.7193+03
7	-1.7090-02	1.3956+03	1.1169+05	1.3153+03	-6.9788+01	-1.6005+03
8	-1.7134-02	1.3960+03	1.1243+05	1.3152+03	-6.9736+01	-1.6122+03
9	-1.7306-02	1.3955+03	1.1128+05	1.3155+03	-6.9112+01	-1.6101+03
10	-3.7525-01	1.2987+03	1.0883+05	1.2187+03	2.6277+00	4.1416+04
11	-4.6582-01	1.2988+03	1.0861+05	1.2189+03	2.5465+00	4.2652+04
12	-3.7690-01	1.2989+03	1.0896+05	1.2188+03	2.3067+00	4.7235+04
13	-9.1373-02	1.2051+03	1.1514+05	1.1186+03	1.6247+00	7.0867+04
14	-8.7326-02	1.2052+03	1.1540+05	1.1185+03	1.5385+00	7.5008+04
15	-8.7429-02	1.2052+03	1.1541+05	1.1185+03	1.5050+00	7.6685+04
16	-2.1136-01	1.2051+03	1.4443+05	1.0962+03	3.3239+00	4.3453+04
17	-1.9044-01	1.2044+03	1.4324+05	1.0964+03	1.1518+00	1.2437+05
18	-2.9394-01	1.2048+03	1.4378+05	1.0964+03	3.3708+00	4.2654+04
19	-3.8564-01	1.2929+03	1.3887+05	1.1904+03	3.4232+00	4.0566+04
20	-2.4496-01	1.2928+03	1.3881+05	1.1904+03	3.4377+00	4.0378+04
21	-9.8282-01	1.2925+03	1.3847+05	1.1902+03	3.6964+00	3.7461+04
22	2.1148-01	1.4166+03	1.2988+05	1.3235+03	3.9170+00	3.3158+04
23	2.4585-01	1.4168+03	1.3034+05	1.3234+03	3.6521+00	3.5690+04
24	2.9301-01	1.4167+03	1.3044+05	1.3233+03	3.7830+00	3.4482+04
25	4.4856-01	1.3904+03	1.6881+05	1.2682+03	4.9469+00	3.4125+04
26	4.3497-01	1.3901+03	1.6843+05	1.2681+03	5.3371+00	3.1559+04
27	3.9706-01	1.3898+03	1.6815+05	1.2681+03	5.5294+00	3.0410+04
28	-1.6813-01	1.2682+03	1.7578+05	1.1372+03	3.8873+00	4.5219+04
29	-1.6803-01	1.2686+03	1.7648+05	1.1371+03	3.7557+00	4.6989+04
30	-1.4209-01	1.2692+03	1.7717+05	1.1372+03	3.5411+00	5.0033+04

CONDENSING DATA REDUCTION

	408	424	434	436	439	440
	NUC TC	TWI BC	Q/A BC	TWO BC	TK-TWI	HCONBC
31	7.4556-02	1.1891+03	1.7510+05	1.0562+03	9.0118+00	1.9430+04
32	9.3917-02	1.1901+03	1.7589+05	1.0566+03	8.5538+00	2.0563+04
33	9.2000-02	1.1894+03	1.7491+05	1.0566+03	9.3636+00	1.8679+04
34	-1.3939-01	1.2907+03	2.1394+05	1.1315+03	5.6404+00	3.7929+04
35	-1.7991-01	1.2903+03	2.1319+05	1.1317+03	5.7015+00	3.7392+04
36	-1.8278-01	1.2903+03	2.1344+05	1.1315+03	6.0493+00	3.5283+04
37	3.4826-01	1.3964+03	2.0745+05	1.2459+03	6.5347+00	3.1746+04
38	3.3262-01	1.3966+03	2.0769+05	1.2459+03	6.7323+00	3.0849+04
39	2.8585-01	1.3961+03	2.0708+05	1.2459+03	7.3278+00	2.8260+04
40	1.2965+00	1.3945+03	2.3438+05	1.2239+03	6.6399+00	3.5299+04
41	1.4403+00	1.3945+03	2.3389+05	1.2243+03	6.4231+00	3.6413+04
42	4.1881-01	1.3937+03	2.3318+05	1.2240+03	7.4108+00	3.1464+04
43	-7.4556-01	1.3387+03	2.3750+05	1.1635+03	7.3329+00	3.2388+04
44	-8.0386+00	1.3376+03	2.3608+05	1.1634+03	7.6791+00	3.0743+04
45	-4.1405-01	1.3379+03	2.3651+05	1.1635+03	6.7254+00	3.5167+04
46	-1.0651-01	1.2635+03	2.1760+05	1.1005+03	6.0292+00	3.6091+04
47	-1.1099-01	1.2635+03	2.1761+05	1.1005+03	6.2009+00	3.5094+04
48	-1.3875-01	1.2634+03	2.1711+05	1.1008+03	.6.0889+00	3.5657+04
49	-1.2522-01	1.2541+03	1.5296+05	1.1400+03	3.2987+00	4.6370+04
50	-1.2826-01	1.2545+03	1.5370+05	1.1398+03	3.0064+00	5.1124+04
51	-1.3515-01	1.2541+03	1.5295+05	1.1400+03	3.3047+00	4.6283+04
52	-2.6983-01	1.2411+03	1.2833+05	1.1453+03	2.7051+00	4.7440+04
53	-2.8932-01	1.2407+03	1.2818+05	1.1450+03	2.2649+00	5.6595+04
54	-1.9029-01	1.2419+03	1.2925+05	1.1454+03	1.8340+00	7.0477+04
55	-1.5763-01	1.2328+03	1.0234+05	1.1564+03	9.3718-01	1.0920+05
56	-1.8362-01	1.2328+03	1.0222+05	1.1565+03	1.1265+00	9.0742+04
57	-1.6698-01	1.2328+03	1.0234+05	1.1565+03	9.4205-01	1.0863+05
58	-2.3719-01	1.2298+03	8.3406+04	1.1677+03	8.9490-01	9.3202+04
59	-2.5991-01	1.2299+03	8.3325+04	1.1678+03	9.5073-01	8.7643+04
60	-2.4550-01	1.2300+03	8.3503+04	1.1677+03	9.2130-01	9.0637+04

CONDENSING DATA REDUCTION

	408	424	434	436	439	440
	NUC TC	TWI BC	Q/A BC	TWO BC	TK-TWI	HCONBC
61	-5.5996-01	1.2296+03	6.9759+04	1.1777+03	7.3232-01	9.5259+04
62	-3.5682-01	1.2296+03	6.9758+04	1.1777+03	6.1153-01	1.1407+05
63	-4.2279-01	1.2296+03	6.9812+04	1.1776+03	5.9781-01	1.1678+05
64	-2.6025-01	1.2158+03	6.4448+04	1.1677+03	3.6780-01	1.7523+05
65	-2.7673-01	1.2160+03	6.4406+04	1.1679+03	3.0412-01	2.1178+05
66	-2.8046-01	1.2160+03	6.3891+04	1.1684+03	3.6621-01	1.7447+05
67	5.3815-02	1.3917+03	2.7070+05	1.1939+03	2.4562+01	1.1021+04
68	4.8030-01	1.4082+03	2.9310+05	1.1944+03	9.1939+00	3.1880+04
69	-8.3396+00	1.4103+03	2.9666+05	1.1938+03	7.4822+00	3.9649+04
70	9.8082-01	1.4295+03	2.7944+05	1.2269+03	7.8583+00	3.5559+04
71	7.1004-01	1.4275+03	2.7777+05	1.2261+03	7.7020+00	3.6065+04
72	-1.1203+00	1.4269+03	2.7698+05	1.2261+03	6.2357+00	4.4419+04

CONDENSING DATA REDUCTION

	442	450	451	452	453	610
	NUC BC	PSI HD	PI	PO	DPC	PIC
1	1.2503-01	2.9424-01	4.5680+00	4.7677+00	-1.9966-01	4.7291+00
2	1.5591-01	2.9341-01	4.5654+00	4.7644+00	-1.9902-01	4.7264+00
3	1.1253-01	2.9491-01	4.5686+00	4.7728+00	-2.0418-01	4.7298+00
4	-6.5309-03	2.0230-01	8.1339+00	6.1448+00	1.9890+00	8.4109+00
5	-6.8197-03	2.0086-01	8.1359+00	6.2142+00	1.9217+00	8.4128+00
6	-7.7193-03	1.9969-01	8.1319+00	6.4235+00	1.7084+00	8.4084+00
7	-4.5960-03	1.7614-01	1.4535+01	8.8329+00	5.7026+00	1.5051+01
8	-4.6299-03	1.7771-01	1.4531+01	8.8650+00	5.6656+00	1.5046+01
9	-4.6241-03	1.7779-01	1.4509+01	8.8739+00	5.6353+00	1.5025+01
10	1.1844-01	3.1302-01	8.4865+00	8.6780+00	-1.9144-01	8.7912+00
11	1.2197-01	3.1106-01	8.4907+00	8.6748+00	-1.8404-01	8.7952+00
12	1.3507-01	3.0761-01	8.4865+00	8.6695+00	-1.8298-01	8.7904+00
13	1.9931-01	5.7588-01	4.5835+00	4.9746+00	3.9107-01	4.7834+00
14	2.1095-01	5.7975-01	4.5816+00	4.9753+00	-3.9369-01	4.7820+00
15	2.1567-01	5.7865-01	4.5835+00	4.9739+00	-3.9039-01	4.7838+00
16	1.2224-01	8.6766-01	4.5551+00	5.0393+00	-4.8420-01	4.7990+00
17	3.4970-01	8.5329-01	4.5538+00	4.9235+00	-3.6972-01	4.7953+00
18	1.1999-01	8.6354-01	4.5648+00	5.0257+00	-4.6088-01	4.8085+00
19	1.1590-01	5.1902-01	8.1500+00	8.4558+00	-3.0580-01	8.4744+00
20	1.1537-01	5.1038-01	8.1420+00	8.4527+00	-3.1070-01	8.4645+00
21	1.0703-01	5.1670-01	8.1571+00	8.4400+00	-2.8286-01	8.4814+00
22	9.6975-02	2.3704-01	1.6207+01	1.6273+01	-6.6423-02	1.6792+01
23	1.0438-01	2.3660-01	1.6203+01	1.6273+01	-7.0014-02	1.6788+01
24	1.0085-01	2.3652-01	1.6200+01	1.6279+01	-7.8989-02	1.6785+01
25	9.9157-02	4.6639-01	1.4225+01	1.4340+01	-1.1516-01	1.4773+01
26	9.1701-02	4.6059-01	1.4221+01	1.4348+01	-1.2621-01	1.4769+01
27	8.8364-02	4.6794-01	1.4221+01	1.4343+01	-1.2147-01	1.4770+01
28	1.2865-01	9.2588-01	6.9032+00	7.3756+00	-4.7247-01	7.2468+00
29	1.3369-01	9.2637-01	6.9154+00	7.3903+00	-4.7492-01	7.2597+00
30	1.4236-01	9.2125-01	6.9163+00	7.4119+00	-4.9557-01	7.2598+00

CONDENSING DATA REDUCTION

	442	450	451	452	453	610
	NUC BC	PSI HD	PI	PO	DPC	PIC
31	5.4569-02	1.3390+00	4.4336+00	4.6455+00	-2.1195-01	4.7536+00
32	5.7754-02	1.3431+00	4.4152+00	4.6714+00	-2.5617-01	4.7354+00
33	5.2464-02	1.3563+00	4.4121+00	4.6746+00	-2.6247-01	4.7346+00
34	1.0837-01	1.1940+00	8.0076+00	8.4622+00	-4.5456-01	8.4368+00
35	1.0683-01	1.1816+00	8.0046+00	8.4442+00	-4.3961-01	8.4315+00
36	1.0081-01	1.1865+00	8.0208+00	8.4643+00	-4.4354-01	8.4492+00
37	9.2393-02	6.5177-01	1.4710+01	1.4925+01	-2.1508-01	1.5304+01
38	8.9794-02	6.5518-01	1.4739+01	1.4953+01	-2.1355-01	1.5335+01
39	8.2258-02	6.5435-01	1.4739+01	1.4964+01	-2.2511-01	1.5335+01
40	1.0268-01	8.3266-01	1.4537+01	1.4788+01	-2.5062-01	1.5155+01
41	1.0592-01	8.2716-01	1.4519+01	1.4771+01	-2.5219-01	1.5136+01
42	9.1527-02	8.2894-01	1.4537+01	1.4788+01	-2.5061-01	1.5154+01
43	9.3329-02	1.1244+00	1.0690+01	1.1125+01	-4.3518-01	1.1209+01
44	8.8576-02	1.1115+00	1.0628+01	1.1082+01	-4.5490-01	1.1143+01
45	1.0131-01	1.1203+00	1.0577+01	1.1051+01	-4.7381-01	1.1091+01
46	1.0263-01	1.3368+00	6.7071+00	7.2792+00	-5.7209-01	7.1119+00
47	9.9802-02	1.3591+00	6.7001+00	7.2893+00	-5.8920-01	7.1085+00
48	1.0140-01	1.3247+00	6.7167+00	7.2718+00	-5.5511-01	7.1198+00
49	1.3158-01	6.9306-01	6.2976+00	6.7824+00	-4.8476-01	6.5777+00
50	1.4508-01	6.9320-01	6.3051+00	6.7867+00	-4.8163-01	6.5856+00
51	1.3134-01	6.9613-01	6.2976+00	6.7841+00	-4.8651-01	6.5781+00
52	1.3430-01	5.0834-01	5.8711+00	6.2367+00	-3.6563-01	6.1099+00
53	1.6019-01	4.9659-01	5.8553+00	6.2001+00	-3.4482-01	6.0923+00
54	1.9951-01	5.0476-01	5.8632+00	6.2334+00	-3.7023-01	6.1014+00
55	3.0859-01	3.2607-01	5.5856+00	5.8505+00	-2.6493-01	5.7863+00
56	2.5643-01	3.2296-01	5.5931+00	5.8576+00	-2.6453-01	5.7934+00
57	3.0699-01	3.2280-01	5.5893+00	5.8505+00	-2.6116-01	5.7896+00
58	2.6324-01	2.1123-01	5.5395+00	5.7312+00	-1.9164-01	5.7249+00
59	2.4754-01	2.1282-01	5.5456+00	5.7334+00	-1.8787-01	5.7312+00
60	2.5600-01	2.1078-01	5.5463+00	5.7365+00	-1.9013-01	5.7317+00

CONDENSING DATA REDUCTION

	442	450	451	452	453	610
	NUC BC	PSI HD	PI	PO	DPC	PIC
61	2.6903-01	1.4486-01	5.5765+00	5.7063+00	-1.2977-01	5.7541+00
62	3.2215-01	1.4382-01	5.5667+00	5.7018+00	-1.3505-01	5.7440+00
63	3.2980-01	1.4399-01	5.5682+00	5.7018+00	-1.3354-01	5.7456+00
64	4.9363-01	1.2796-01	5.0992+00	5.2289+00	-1.2972-01	5.2606+00
65	5.9660-01	1.2910-01	5.1046+00	5.2304+00	-1.2570-01	5.2665+00
66	4.9151-01	1.2442-01	5.1053+00	5.2354+00	-1.3004-01	5.2667+00
67	3.2195-02	1.1369+00	1.5411+01	1.6024+01	-6.1216-01	1.6117+01
68	9.3157-02	1.1141+00	1.5446+01	1.6135+01	-6.8912-01	1.6149+01
69	1.1587-01	1.1830+00	1.5432+01	1.6167+01	-7.3524-01	1.6147+01
70	1.0448-01	9.5114-01	1.7380+01	1.7711+01	-3.3072-01	1.8132+01
71	1.0590-01	9.6750-01	1.7078+01	1.7559+01	-4.8167-01	1.7819+01
72	1.3036-01	9.6140-01	1.6945+01	1.7376+01	-4.3127-01	1.7679+01

CONDENSING DATA REDUCTION

	611	613	700	495	701	498
	POC	DPCC	X B	WKL B	X T	WKL T
1	4.8621+00	-1.3301-01	2.7124-01	3.0414+01	8.6918-01	5.4598+00
2	4.8586+00	-1.3225-01	2.7124-01	3.0363+01	8.6918-01	5.4505+00
3	4.8677+00	-1.3784-01	2.7191-01	3.0423+01	8.6964-01	5.4470+00
4	6.2897+00	2.1212+00	2.6209-01	3.3329+01	8.6931-01	5.9027+00
5	6.3618+00	2.0511+00	2.5581-01	3.3496+01	8.6333-01	6.1516+00
6	6.5755+00	1.8329+00	2.3969-01	3.4114+01	8.4848-01	6.7986+00
7	9.0857+00	5.9652+00	5.0672-01	2.7208+01	1.1861+00	-1.0262+01
8	9.1184+00	5.9277+00	4.9366-01	2.8048+01	1.1642+00	-9.0941+00
9	9.1274+00	5.8971+00	4.9010-01	2.8234+01	1.1586+00	-8.7833+00
10	8.9208+00	-1.2967-01	2.6260-01	4.2285+01	8.6312-01	7.8491+00
11	8.9174+00	-1.2227-01	2.6212-01	4.2190+01	8.6279-01	7.8454+00
12	8.9118+00	-1.2142-01	2.6190-01	4.1956+01	8.6264-01	7.8082+00
13	5.0742+00	-2.9079-01	2.7970-01	4.2279+01	8.7500-01	7.3371+00
14	5.0749+00	-2.9288-01	2.8015-01	4.2388+01	8.7530-01	7.3429+00
15	5.0735+00	-2.8971-01	2.7981-01	4.2376+01	8.7507-01	7.3510+00
16	5.1415+00	-3.4250-01	2.7931-01	5.2002+01	8.7466-01	9.0439+00
17	5.0224+00	-2.2713-01	2.7256-01	5.2034+01	8.6999-01	9.2996+00
18	5.1269+00	-3.1839-01	2.7777-01	5.2036+01	8.7360-01	9.1069+00
19	8.6901+00	-2.1577-01	2.6766-01	5.3166+01	8.6657-01	9.6865+00
20	8.6870+00	-2.2249-01	2.6763-01	5.2695+01	8.6656-01	9.6010+00
21	8.6740+00	-1.9260-01	2.6669-01	5.3137+01	8.6590-01	9.7174+00
22	1.6851+01	-5.8569-02	2.6020-01	4.9795+01	8.6136-01	9.3317+00
23	1.6851+01	-6.2259-02	2.6024-01	4.9741+01	8.6139-01	9.3201+00
24	1.6856+01	-7.1657-02	2.6047-01	4.9711+01	8.6155-01	9.3065+00
25	1.4833+01	-6.0229-02	2.5934-01	6.5906+01	8.6077-01	1.2389+01
26	1.4842+01	-7.2808-02	2.5927-01	6.5493+01	8.6073-01	1.2314+01
27	1.4837+01	-6.6699-02	2.5952-01	6.5993+01	8.6090-01	1.2397+01
28	7.5683+00	-3.2159-01	2.6925-01	6.5909+01	8.6773-01	1.1930+01
29	7.5840+00	-3.2430-01	2.6929-01	6.5978+01	8.6775-01	1.1941+01
30	7.6066+00	-3.4687-01	2.6982-01	6.5748+01	8.6813-01	1.1874+01

CONDENSING DATA REDUCTION

	611	613	700	495	701	498
	POC	DPCC	X B	WKL B	X T	WKL T
31	4.7342+00	1.9427-02	2.5537-01	6.6453+01	8.5800-01	1.2673+01
32	4.7605+00	-2.5054-02	2.5726-01	6.6268+01	8.5935-01	1.2549+01
33	4.7638+00	-2.9213-02	2.5771-01	6.6547+01	8.5966-01	1.2582+01
34	8.6963+00	-2.5945-01	2.6431-01	8.0841+01	8.6428-01	1.4914+01
35	8.6780+00	-2.4641-01	2.6383-01	8.0452+01	8.6395-01	1.4869+01
36	8.6984+00	-2.4919-01	2.6395-01	8.0683+01	8.6403-01	1.4905+01
37	1.5443+01	-1.3899-01	2.6005-01	7.9118+01	8.6128-01	1.4832+01
38	1.5473+01	-1.3714-01	2.6004-01	7.9400+01	8.6128-01	1.4886+01
39	1.5485+01	-1.4950-01	2.6017-01	7.9336+01	8.6137-01	1.4866+01
40	1.5298+01	-1.4298-01	2.6001-01	8.9027+01	8.6125-01	1.6693+01
41	1.5280+01	-1.4456-01	2.5999-01	8.8683+01	8.6123-01	1.6630+01
42	1.5298+01	-1.4363-01	2.6002-01	8.8825+01	8.6126-01	1.6654+01
43	1.1474+01	-2.6418-01	2.6264-01	8.9670+01	8.6311 01	1.6647+01
44	1.1431+01	-2.8803-01	2.6291-01	8.8873+01	8.6330-01	1.6482+01
45	1.1398+01	-3.0706-01	2.6352-01	8.8961+01	8.6372-01	1.6461+01
46	7.4655+00	-3.5362-01	2.6730-01	7.8720+01	8.6640-01	1.4354+01
47	7.4763+00	-3.6776-01	2.6792-01	7.9288+01	8.6682-01	1.4424+01
48	7.4576+00	-3.3780-01	2.6675-01	7.8463+01	8.6601-01	1.4337+01
49	6.9482+00	-3.7051-01	2.7338-01	5.4217+01	8.7065-01	9.6516+00
50	6.9526+00	-3.6708-01	2.7318-01	5.4267+01	8.7051-01	9.6681+00
51	6.9500+00	-3.7184-01	2.7361-01	5.4321+01	8.7080-01	9.6618+00
52	6.3851+00	-2.7520-01	2.7164-01	4.4983+01	8.6946-01	8.0618+00
53	6.3478+00	-2.5554-01	2.7032-01	4.4480+01	8.6856-01	8.0127+00
54	6.3818+00	-2.8031-01	2.7187-01	4.4781+01	8.6963-01	8.0180+00
55	5.9847+00	-1.9843-01	2.7027-01	3.5197+01	8.6853-01	6.3411+00
56	5.9920+00	-1.9855-01	2.7005-01	3.5059+01	8.6839-01	6.3212+00
57	5.9847+00	-1.9508-01	2.6982-01	3.5051+01	8.6823-01	6.3255+00
58	5.8595+00	-1.3464-01	2.6677-01	2.8324+01	8.6612-01	5.1715+00
59	5.8619+00	-1.3076-01	2.6653-01	2.8454+01	8.6595-01	5.2005+00
60	5.8652+00	-1.3350-01	2.6659-01	2.8317+01	8.6600-01	5.1738+00

CONDENSING DATA REDUCTION

	611	613	700	495	701	498
	POC	DPCC	X B	WKL B	X T	WKL T
61	5.8329+00	-7.8801-02	2.6216-01	2.3659+01	8.6290-01	4.3962+00
62	5.8280+00	-8.4012-02	2.6274-01	2.3536+01	8.6331-01	4.3637+00
63	5.8280+00	-8.2441-02	2.6258-01	2.3559+01	8.6320-01	4.3705+00
64	5.3392+00	-7.8562-02	2.6272-01	2.1316+01	8.6332-01	3.9516+00
65	5.3406+00	-7.4113-02	2.6246-01	2.1430+01	8.6313-01	3.9770+00
66	5.3458+00	-7.9046-02	2.6267-01	2.1032+01	8.6329-01	3.8997+00
67	1.6594+01	-4.7740-01	2.6190-01	1.0675+02	8.6262-01	1.9870+01
68	1.6709+01	-5.5966-01	2.6230-01	1.0572+02	8.6292-01	1.9645+01
69	1.6742+01	-5.9467-01	2.6383-01	1.0871+02	8.6396-01	2.0088+01
70	1.8361+01	-2.2950-01	2.6026-01	1.0334+02	8.6143-01	1.9358+01
71	1.8203+01	-3.8432-01	2.6234-01	1.0310+02	8.6289-01	1.9164+01
72	1.8010+01	-3.3061-01	2.6191-01	1.0246+02	8.6258-01	1.9077+01

CONDENSING DATA REDUCTION

	504	507
	NREF T	NREF B
1	3.7293+02	2.0809+03
2	3.7227+02	2.0772+03
3	3.7207+02	2.0817+03
4	4.2392+02	2.3529+03
5	4.4187+02	2.3667+03
6	4.8855+02	2.4163+03
7	-7.7675+02	2.0005+03
8	-6.8835+02	2.0628+03
9	-6.6476+02	2.0765+03
10	5.6845+02	3.0652+03
11	5.6821+02	3.0582+03
12	5.6548+02	3.0411+03
13	5.0198+02	2.9028+03
14	5.0236+02	2.9104+03
15	5.0293+02	2.9095+03
16	6.1906+02	3.5743+03
17	6.3627+02	3.5699+03
18	6.2344+02	3.5761+03
19	6.9931+02	3.8436+03
20	6.9308+02	3.8094+03
21	7.0157+02	3.8411+03
22	7.1977+02	3.8415+03
23	7.1886+02	3.8373+03
24	7.1781+02	3.8351+03
25	9.4389+02	5.0226+03
26	9.3814+02	4.9913+03
27	9.4451+02	5.0293+03
28	8.4900+02	4.7026+03
29	8.4991+02	4.7085+03
30	8.4518+02	4.6932+03

CONDENSING DATA REDUCTION

	504 NREF T	507 NREF B
31	8.6559+02	4.5379+03
32	8.5696+02	4.5268+03
33	8.5917+02	4.5461+03
34	1.0763+03	5.8441+03
35	1.0730+03	5.8151+03
36	1.0758+03	5.8330+03
37	1.1343+03	6.0534+03
38	1.1385+03	6.0761+03
39	1.1371+03	6.0715+03
40	1.2754+03	6.8056+03
41	1.2704+03	6.7786+03
42	1.2725+03	6.7901+03
43	1.2355+03	6.6643+03
44	1.2226+03	6.6023+03
45	1.2205+03	6.6068+03
46	1.0197+03	5.6087+03
47	1.0247+03	5.6497+03
48	1.0186+03	5.5900+03
49	6.8060+02	3.8355+03
50	6.8184+02	3.8393+03
51	6.8133+02	3.8430+03
52	5.6446+02	3.1574+03
53	5.6084+02	3.1206+03
54	5.6133+02	3.1431+03
55	4.4169+02	2.4562+03
56	4.4035+02	2.4469+03
57	4.4062+02	2.4461+03
58	3.5981+02	1.9732+03
59	3.6185+02	1.9824+03
60	3.6000+02	1.9729+03

CONDENSING DATA REDUCTION

	504	507
	NREF T	NREF B
61	3.0596+02	1.6479+03
62	3.0366+02	1.6392+03
63	3.0414+02	1.6407+03
64	2.7270+02	1.4724+03
65	2.7448+02	1.4803+03
66	2.6915+02	1.4530+03
67	1.5273+03	8.2194+03
68	1.5104+03	8.1441+03
69	1.5445+03	8.3756+03
70	1.5034+03	8.0312+03
71	1.4862+03	8.0049+03
72	1.4784+03	7.9483+03

K Inlet

0.375-inch I.D.

Wall Thermocouple

SS 316 Collar

Sodium

1.85-inch O.D.

8-inch

Active Condensing
Length = 36 inches

8-inch

Sodium

Wall Thermocouple

K Outlet
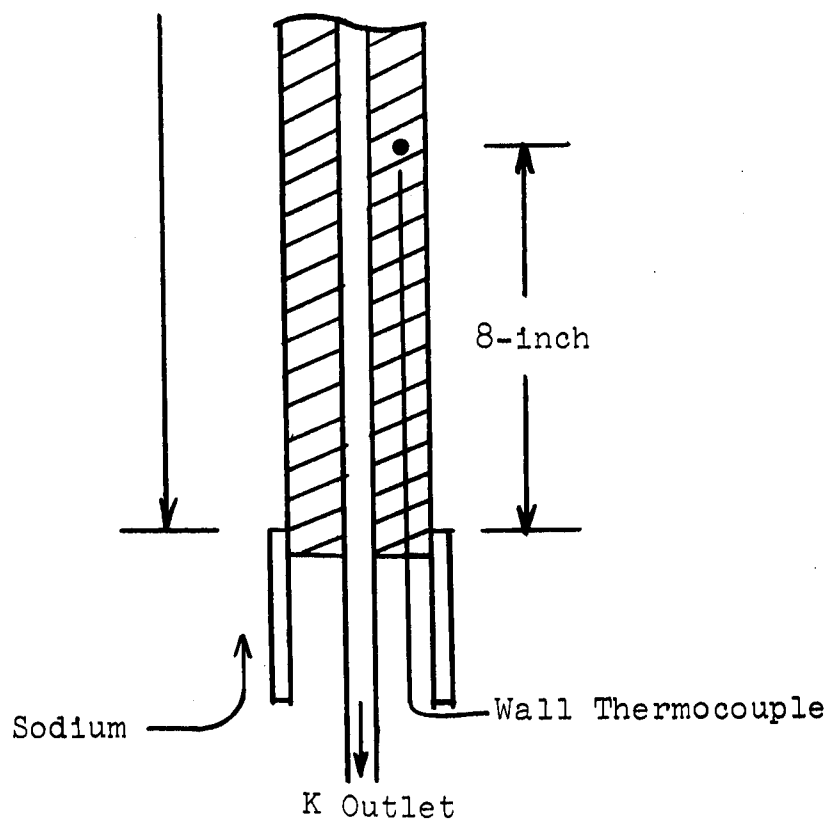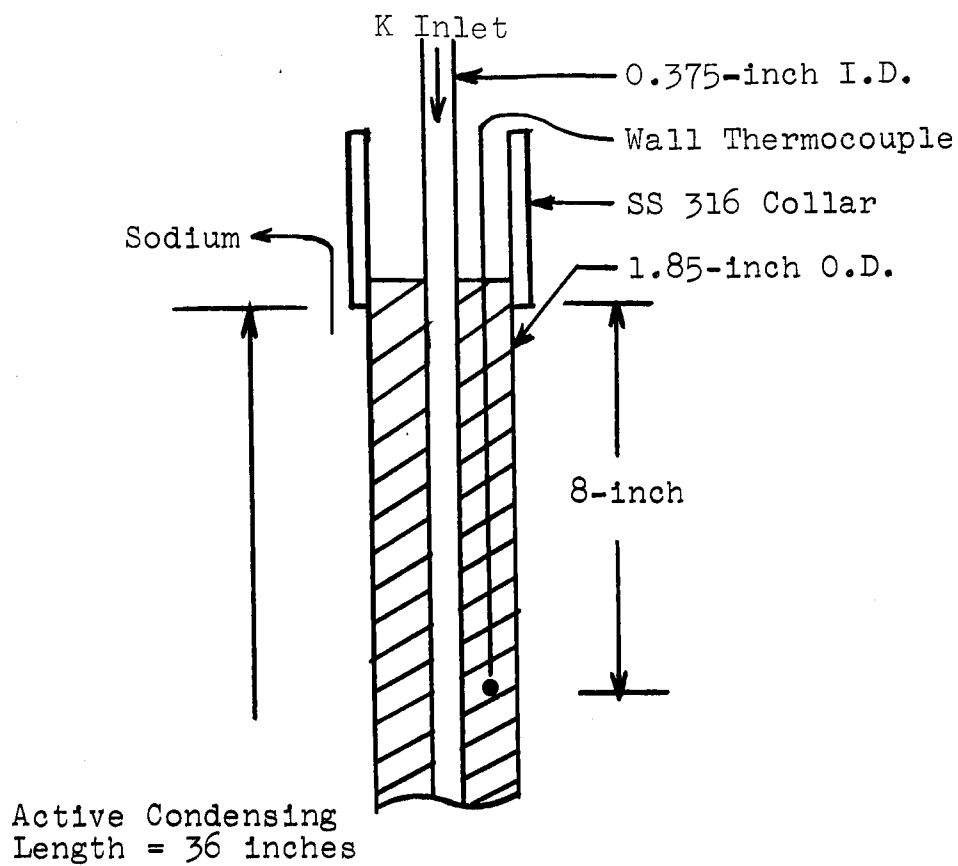
50 KW Test Section Schematic
(3/8-inch ID plain tube, Test Set No. 3, January, 1965)

TABLE D-3. NOMENCLATURE FOR CONDENSING HEAT TRANSFER
RESULTS FROM THE 50 KW FACILITY
(Key to Table D-4)

Column	Symbol	Identification
131	DATE	(e.g., 1.1050 + 03 = 1/10/65)
132	TIME	(e.g., 1.200 + 03 = 1200)

Fluid Thermocouples

Column	TC Number	
134	1	Potassium inlet
136	2	Potassium inlet
138	3	Potassium outlet
140	4	Potassium outlet
142	5	Sodium outlet
144	6	Sodium outlet
146	7	Sodium outlet
148	8	Sodium inlet
150	9	Sodium inlet
152	10	Sodium inlet

Wall Thermocouples

Column	TC Number	Radius Within Tube Wall - Inches	Distance from Condenser Inlet - Inches
154	11	.293	8
156	12	.288	8
158	13	.412	8
160	14	.834	8
162	15	.822	8
164	16	.291	28
166	17	.293	28
168	18	.410	28
170	19	.830	28
172	20	.828	28

Column	Symbol	Identification
174	TKI	Inlet potassium temperature, $^\circ$F
176	TKO	Outlet potassium temperature, $^\circ$F
181-219	TKNC	Corrected temperature of thermocouple N, $^\circ$F
221	TKICC	Corrected inlet potassium temperature, $^\circ$F
223	TKOC	Corrected outlet potassium temperature, $^\circ$F
226	TNAO	Outlet Sodium temperature, $^\circ$F
229	TNAI	Inlet Sodium temperature, $^\circ$F
230	DTNA	Sodium temperature increase, $^\circ$F
235	WNA	Sodium Flow rate, lb/hr
237	TNAM	Sodium mean temperature, $^\circ$F
238	CPNA	Sodium specific heat, Btu/lb-$^\circ$F
240	QNA	Sodium heat gain, Btu/hr
243	DTQL	Temperature Difference, Test Section Shell - Ambient, $^\circ$F
246	QC	Condenser load, Btu/hr
247	Q/AA	Average heat flux, Btu/hr-ft^2
251	WK	Potassium flow rate, lb/hr
306	TWIT*	Inner wall temperature at top axial station, $^\circ$F
317	Q/AT*	Heat Flux at inner wall at top axial station, Btu/hr-ft^2
319	TWOT*	Outer wall temperature at top axial station, $^\circ$F
323	TK-TWI*	Potassium - Inner wall temperature
324	HCONT*	Condensing heat transfer coefficient at top axial station, Btu/hr-ft^2 $^\circ$F
326	NUCT*	Nusselt's condensing ratio at top axial station, dimensionless
354	TWIB*	Inner wall temperature at bottom axial station, $^\circ$F
365	Q/AB*	Heat Flux at inner wall at bottom axial station, Btu/hr-ft^2
367	TWOB*	Outer wall temperature at bottom axial station, $^\circ$F
372	HCONB*	Condensing heat transfer coefficient at bottom axial station, Btu/hr-ft^2-$^\circ$F
374	NUCB*	Nusselt's condensing ratio at bottom axial station, dimensionless
450	PSI HD	Inlet vapor velocity head, psi
451	PI*	Inlet potassium vapor pressure, lb/in^2
452	PO*	Outlet potassium vapor pressure, lb/in^2
453	DPC*	Condensing pressure drop

*These values were also calculated, accounting for the thermo-couple standardizations obtained in the vapor standardization runs. The values of the parameters utilizing the thermocouple standardization are indicated in the columns in which the notation for the above parameters are followed by a C, e.g., TWITC is the Inner Wall Temperature at top axial station utilizing the standardized correction factor, $^\circ$F.

Column	Symbol	Identification
700	X B	Potassium Quality, Bottom Station, L/D = 75
495	WKL B	Local Potassium liquid flowrate at bottom station, lb/hr
701	X T	Potassium Quality, Top Station, L/D = 21
498	WKL T	Local Potassium liquid flowrate at top station, lb/hr
504	NREF T	Liquid film Reynolds number at top station, L/D = 21
507	NREF B	Liquid film Reynolds number at bottom station, L/D = 75

CONDENSING DATA REDUCTION (Test Set No. 3)

	131	132	134	138	140	142
	DATE	TIME	TC1	TC3	TC4	TC5
1	1.1050+03	1.2000+03	1.1865+03	1.2006+03	1.1916+03	1.1412+03
2	1.1050+03	1.2000+03	1.1867+03	1.2006+03	1.1916+03	1.1413+03
3	1.1050+03	1.2000+03	1.1867+03	1.2006+03	1.1916+03	1.1411+03
*4	1.1050+03	1.5000+03	1.1877+03	1.1973+03	1.1882+03	1.1196+03
*5	1.1050+03	1.5000+03	1.1878+03	1.1971+03	1.1879+03	1.1195+03
*6	1.1050+03	1.5000+03	1.1877+03	1.1971+03	1.1880+03	1.1193+03
7	1.1050+03	1.8000+03	1.2408+03	1.2541+03	1.2449+03	1.1945+03
8	1.1050+03	1.8000+03	1.2412+03	1.2543+03	1.2453+03	1.1949+03
9	1.1050+03	1.8000+03	1.2412+03	1.2543+03	1.2452+03	1.1950+03
10	1.1050+03	2.0000+03	1.3013+03	1.3109+03	1.3012+03	1.2555+03
11	1.1050+03	2.0000+03	1.3016+03	1.3110+03	1.3013+03	1.2555+03
12	1.1050+03	2.0000+03	1.3016+03	1.3111+03	1.3013+03	1.2556+03
13	1.1150+03	2.3000+02	1.3972+03	1.4037+03	1.3922+03	1.3468+03
14	1.1150+03	2.3000+02	1.3974+03	1.4039+03	1.3924+03	1.3471+03
15	1.1150+03	2.3000+02	1.3976+03	1.4039+03	1.3922+03	1.3474+03
16	1.1150+03	9.0000+02	1.2404+03	1.2585+03	1.2487+03	1.1788+03
17	1.1150+03	9.0000+02	1.2404+03	1.2583+03	1.2484+03	1.1788+03
18	1.1150+03	9.0000+02	1.2405+03	1.2584+03	1.2486+03	1.1788+03
*19	1.1150+03	1.5300+03	1.2076+03	1.1964+03	1.1866+03	1.1012+03
*20	1.1150+03	1.5300+03	1.2080+03	1.1964+03	1.1866+03	1.1010+03
*21	1.1150+03	1.5300+03	1.2077+03	1.1964+03	1.1867+03	1.1010+03
*22	1.1150+03	2.0450+03	1.2469+03	1.1868+03	1.1787+03	1.0727+03
*23	1.1150+03	2.0450+03	1.2466+03	1.1870+03	1.1788+03	1.0729+03
*24	1.1150+03	2.0450+03	1.2468+03	1.1873+03	1.1791+03	1.0732+03
25	1.1250+03	2.0000+02	1.2985+03	1.3159+03	1.3057+03	1.2261+03
26	1.1250+03	2.0000+02	1.2987+03	1.3159+03	1.3058+03	1.2261+03
27	1.1250+03	2.0000+02	1.2985+03	1.3159+03	1.3057+03	1.2260+03
28	1.1250+03	4.3000+02	1.3919+03	1.4027+03	1.3910+03	1.3105+03
29	1.1250+03	4.3000+02	1.3919+03	1.4027+03	1.3910+03	1.3105+03
30	1.1250+03	4.3000+02	1.3920+03	1.4029+03	1.3912+03	1.3106+03

*Subcooled liquid at test section outlet, therefore calculational procedure not valid. Not plotted in Figure 20.

CONDENSING DATA REDUCTION

	144	146	148	150	152	154
	TC6	TC7	TC8	TC9	TC10	TC11
1	1.1422+03	1.1286+03	1.1317+03	1.1330+03	1.1326+03	1.1529+03
2	1.1422+03	1.1286+03	1.1317+03	1.1328+03	1.1324+03	1.1528+03
3	1.1421+03	1.1285+03	1.1316+03	1.1328+03	1.1325+03	1.1528+03
4	1.1203+03	1.1069+03	1.1067+03	1.1078+03	1.1074+03	1.1349+03
5	1.1204+03	1.1069+03	1.1066+03	1.1077+03	1.1074+03	1.1350+03
6	1.1203+03	1.1068+03	1.1066+03	1.1077+03	1.1074+03	1.1349+03
7	1.1956+03	1.1814+03	1.1838+03	1.1851+03	1.1849+03	1.2109+03
8	1.1959+03	1.1817+03	1.1840+03	1.1853+03	1.1850+03	1.2110+03
9	1.1958+03	1.1817+03	1.1842+03	1.1856+03	1.1853+03	1.2112+03
10	1.2566+03	1.2418+03	1.2448+03	1.2462+03	1.2460+03	1.2724+03
11	1.2567+03	1.2420+03	1.2450+03	1.2464+03	1.2462+03	1.2726+03
12	1.2567+03	1.2420+03	1.2450+03	1.2464+03	1.2462+03	1.2727+03
13	1.3482+03	1.3326+03	1.3359+03	1.3374+03	1.3372+03	1.3657+03
14	1.3486+03	1.3328+03	1.3363+03	1.3378+03	1.3376+03	1.3658+03
15	1.3488+03	1.3332+03	1.3365+03	1.3376+03	1.3377+03	1.3659+03
16	1.1798+03	1.1660+03	1.1634+03	1.1645+03	1.1644+03	1.2041+03
17	1.1798+03	1.1660+03	1.1633+03	1.1646+03	1.1644+03	1.2042+03
18	1.1797+03	1.1660+03	1.1632+03	1.1644+03	1.1643+03	1.2041+03
19	1.1019+03	1.0891+03	1.0852+03	1.0863+03	1.0863+03	1.1231+03
20	1.1017+03	1.0889+03	1.0850+03	1.0861+03	1.0861+03	1.1231+03
21	1.1018+03	1.0889+03	1.0850+03	1.0861+03	1.0862+03	1.1231+03
22	1.0732+03	1.0608+03	1.0514+03	1.0524+03	1.0526+03	1.1144+03
23	1.0734+03	1.0611+03	1.0518+03	1.0528+03	1.0529+03	1.1146+03
24	1.0737+03	1.0612+03	1.0518+03	1.0528+03	1.0529+03	1.1147+03
25	1.2267+03	1.2127+03	1.2056+03	1.2069+03	1.2068+03	1.2621+03
26	1.2267+03	1.2127+03	1.2056+03	1.2069+03	1.2068+03	1.2622+03
27	1.2265+03	1.2126+03	1.2055+03	1.2068+03	1.2068+03	1.2621+03
28	1.3114+03	1.2966+03	1.2874+03	1.2888+03	1.2888+03	1.3532+03
29	1.3112+03	1.2967+03	1.2875+03	1.2891+03	1.2889+03	1.3533+03
30	1.3113+03	1.2967+03	1.2875+03	1.2891+03	1.2889+03	1.3532+03

CONDENSING DATA REDUCTION

	156	158	160	162	164	166
	TC12	TC13	TC14	TC15	TC16	TC17
1	1.1729+03	1.1628+03	1.1447+03	1.1294+03	1.1710+03	1.1763+03
2	1.1729+03	1.1627+03	1.1445+03	1.1292+03	1.1709+03	1.1762+03
3	1.1728+03	1.1626+03	1.1445+03	1.1292+03	1.1709+03	1.1763+03
4	1.1547+03	1.1434+03	1.1233+03	1.1077+03	1.1601+03	1.1643+03
5	1.1547+03	1.1435+03	1.1234+03	1.1078+03	1.1601+03	1.1642+03
6	1.1546+03	1.1433+03	1.1235+03	1.1077+03	1.1602+03	1.1642+03
7	1.2319+03	1.2200+03	1.1989+03	1.1830+03	1.2253+03	1.2306+03
8	1.2321+03	1.2201+03	1.1988+03	1.1830+03	1.2252+03	1.2306+03
9	1.2322+03	1.2203+03	1.1992+03	1.1833+03	1.2255+03	1.2309+03
10	1.2944+03	1.2819+03	1.2596+03	1.2434+03	1.2835+03	1.2893+03
11	1.2947+03	1.2822+03	1.2598+03	1.2435+03	1.2835+03	1.2893+03
12	1.2947+03	1.2822+03	1.2599+03	1.2437+03	1.2838+03	1.2897+03
13	1.3900+03	1.3759+03	1.3516+03	1.3347+03	1.3748+03	1.3814+03
14	1.3901+03	1.3762+03	1.3519+03	1.3351+03	1.3750+03	1.3816+03
15	1.3903+03	1.3764+03	1.3523+03	1.3355+03	1.3752+03	1.3818+03
16	1.2249+03	1.2103+03	1.1845+03	1.1686+03	1.2226+03	1.2267+03
17	1.2250+03	1.2103+03	1.1844+03	1.1686+03	1.2226+03	1.2265+03
18	1.2248+03	1.2102+03	1.1843+03	1.1684+03	1.2224+03	1.2264+03
19	1.1422+03	1.1288+03	1.1056+03	1.0904+03	1.1510+03	1.1546+03
20	1.1421+03	1.1287+03	1.1056+03	1.0904+03	1.1510+03	1.1546+03
21	1.1422+03	1.1289+03	1.1056+03	1.0905+03	1.1512+03	1.1546+03
22	1.1327+03	1.1135+03	1.0791+03	1.0633+03	1.1253+03	1.1277+03
23	1.1329+03	1.1137+03	1.0793+03	1.0636+03	1.1253+03	1.1278+03
24	1.1330+03	1.1138+03	1.0794+03	1.0637+03	1.1256+03	1.1280+03
25	1.2838+03	1.2656+03	1.2333+03	1.2160+03	1.2767+03	1.2804+03
26	1.2839+03	1.2657+03	1.2334+03	1.2161+03	1.2766+03	1.2803+03
27	1.2838+03	1.2656+03	1.2333+03	1.2161+03	1.2768+03	1.2805+03
28	1.3769+03	1.3560+03	1.3190+03	1.3006+03	1.3626+03	1.3668+03
29	1.3770+03	1.3561+03	1.3191+03	1.3009+03	1.3628+03	1.3669+03
30	1.3769+03	1.3560+03	1.3190+03	1.3007+03	1.3628+03	1.3669+03

CONDENSING DATA REDUCTION

	168	170	172	174	176	181
	TC18	TC19	TC20	TKI	TKO	TC1C
1	1.1694+03	1.1439+03	1.1417+03	1.1865+03	1.1961+03	1.1865+03
2	1.1693+03	1.1437+03	1.1416+03	1.1867+03	1.1961+03	1.1867+03
3	1.1694+03	1.1438+03	1.1417+03	1.1867+03	1.1961+03	1.1867+03
4	1.1549+03	1.1223+03	1.1200+03	1.1877+03	1.1927+03	1.1877+03
5	1.1550+03	1.1224+03	1.1200+03	1.1878+03	1.1925+03	1.1878+03
6	1.1548+03	1.1223+03	1.1200+03	1.1877+03	1.1926+03	1.1877+03
7	1.2236+03	1.1969+03	1.1946+03	1.2408+03	1.2495+03	1.2408+03
8	1.2236+03	1.1968+03	1.1945+03	1.2412+03	1.2498+03	1.2412+03
9	1.2239+03	1.1972+03	1.1949+03	1.2412+03	1.2498+03	1.2412+03
10	1.2829+03	1.2571+03	1.2548+03	1.3013+03	1.3061+03	1.3013+03
11	1.2830+03	1.2573+03	1.2549+03	1.3016+03	1.3062+03	1.3016+03
12	1.2833+03	1.2575+03	1.2551+03	1.3016+03	1.3062+03	1.3016+03
13	1.3753+03	1.3487+03	1.3459+03	1.3972+03	1.3980+03	1.3972+03
14	1.3755+03	1.3492+03	1.3464+03	1.3974+03	1.3981+03	1.3974+03
15	1.3757+03	1.3494+03	1.3466+03	1.3976+03	1.3981+03	1.3976+03
16	1.2165+03	1.1811+03	1.1783+03	1.2404+03	1.2536+03	1.2404+03
17	1.2163+03	1.1808+03	1.1781+03	1.2404+03	1.2534+03	1.2404+03
18	1.2163+03	1.1807+03	1.1780+03	1.2405+03	1.2535+03	1.2405+03
19	1.1430+03	1.1043+03	1.1015+03	1.2076+03	1.1915+03	1.2076+03
20	1.1430+03	1.1043+03	1.1015+03	1.2080+03	1.1915+03	1.2080+03
21	1.1430+03	1.1042+03	1.1014+03	1.2077+03	1.1916+03	1.2077+03
22	1.1146+03	1.0729+03	1.0704+03	1.2469+03	1.1827+03	1.2469+03
23	1.1147+03	1.0730+03	1.0705+03	1.2466+03	1.1829+03	1.2466+03
24	1.1150+03	1.0733+03	1.0708+03	1.2468+03	1.1832+03	1.2468+03
25	1.2683+03	1.2265+03	1.2235+03	1.2985+03	1.3108+03	1.2985+03
26	1.2682+03	1.2265+03	1.2234+03	1.2987+03	1.3109+03	1.2987+03
27	1.2683+03	1.2265+03	1.2235+03	1.2985+03	1.3108+03	1.2985+03
28	1.3541+03	1.3099+03	1.3066+03	1.3919+03	1.3969+03	1.3919+03
29	1.3541+03	1.3099+03	1.3065+03	1.3919+03	1.3969+03	1.3919+03
30	1.3542+03	1.3100+03	1.3068+03	1.3920+03	1.3970+03	1.3920+03

CONDENSING DATA REDUCTION

	185 TC3C	187 TC4C	189 TC5C	191 TC6C	193 TC7C	195 TC8C
1	1.1966+03	1.1954+03	1.1441+03	1.1440+03	1.1434+03	1.1317+03
2	1.1967+03	1.1954+03	1.1442+03	1.1441+03	1.1435+03	1.1317+03
3	1.1967+03	1.1954+03	1.1441+03	1.1439+03	1.1433+03	1.1316+03
4	1.1933+03	1.1919+03	1.1225+03	1.1221+03	1.1215+03	1.1067+03
5	1.1931+03	1.1917+03	1.1224+03	1.1222+03	1.1216+03	1.1066+03
6	1.1931+03	1.1918+03	1.1222+03	1.1221+03	1.1214+03	1.1066+03
7	1.2501+03	1.2492+03	1.1976+03	1.1975+03	1.1969+03	1.1838+03
8	1.2504+03	1.2496+03	1.1979+03	1.1978+03	1.1972+03	1.1840+03
9	1.2504+03	1.2495+03	1.1980+03	1.1977+03	1.1972+03	1.1842+03
10	1.3070+03	1.3061+03	1.2587+03	1.2586+03	1.2580+03	1.2448+03
11	1.3071+03	1.3062+03	1.2587+03	1.2587+03	1.2582+03	1.2450+03
12	1.3072+03	1.3062+03	1.2588+03	1.2587+03	1.2582+03	1.2450+03
13	1.3998+03	1.3980+03	1.3502+03	1.3504+03	1.3499+03	1.3359+03
14	1.4000+03	1.3981+03	1.3506+03	1.3508+03	1.3501+03	1.3363+03
15	1.4000+03	1.3980+03	1.3508+03	1.3510+03	1.3505+03	1.3365+03
16	1.2546+03	1.2531+03	1.1818+03	1.1817+03	1.1813+03	1.1634+03
17	1.2543+03	1.2528+03	1.1818+03	1.1817+03	1.1813+03	1.1633+03
18	1.2544+03	1.2530+03	1.1818+03	1.1816+03	1.1813+03	1.1632+03
19	1.1924+03	1.1904+03	1.1040+03	1.1037+03	1.1035+03	1.0852+03
20	1.1924+03	1.1903+03	1.1038+03	1.1035+03	1.1033+03	1.0850+03
21	1.1924+03	1.1904+03	1.1038+03	1.1035+03	1.1033+03	1.0850+03
22	1.1828+03	1.1823+03	1.0755+03	1.0749+03	1.0749+03	1.0514+03
23	1.1830+03	1.1825+03	1.0756+03	1.0751+03	1.0751+03	1.0518+03
24	1.1833+03	1.1828+03	1.0760+03	1.0754+03	1.0753+03	1.0518+03
25	1.3120+03	1.3106+03	1.2292+03	1.2287+03	1.2286+03	1.2056+03
26	1.3120+03	1.3107+03	1.2292+03	1.2287+03	1.2286+03	1.2056+03
27	1.3119+03	1.3106+03	1.2291+03	1.2285+03	1.2285+03	1.2055+03
28	1.3988+03	1.3967+03	1.3138+03	1.3136+03	1.3135+03	1.2874+03
29	1.3988+03	1.3968+03	1.3138+03	1.3134+03	1.3135+03	1.2875+03
30	1.3990+03	1.3969+03	1.3139+03	1.3134+03	1.3136+03	1.2875+03

CONDENSING DATA REDUCTION

	197	199	201	203	205	207
	TC9C	TC10C	TC11C	TC12C	TC13C	TC14C
1	1.1323+03	1.1319+03	1.1682+03	1.1688+03	1.1606+03	1.1455+03
2	1.1321+03	1.1317+03	1.1681+03	1.1688+03	1.1605+03	1.1453+03
3	1.1321+03	1.1318+03	1.1681+03	1.1686+03	1.1604+03	1.1453+03
4	1.1071+03	1.1067+03	1.1499+03	1.1506+03	1.1412+03	1.1240+03
5	1.1070+03	1.1067+03	1.1500+03	1.1506+03	1.1413+03	1.1241+03
6	1.1070+03	1.1067+03	1.1499+03	1.1505+03	1.1411+03	1.1241+03
7	1.1845+03	1.1843+03	1.2272+03	1.2276+03	1.2180+03	1.2001+03
8	1.1846+03	1.1844+03	1.2274+03	1.2278+03	1.2181+03	1.2000+03
9	1.1849+03	1.1847+03	1.2275+03	1.2280+03	1.2183+03	1.2004+03
10	1.2456+03	1.2454+03	1.2898+03	1.2901+03	1.2800+03	1.2612+03
11	1.2458+03	1.2456+03	1.2901+03	1.2904+03	1.2803+03	1.2614+03
12	1.2457+03	1.2456+03	1.2902+03	1.2904+03	1.2803+03	1.2615+03
13	1.3368+03	1.3367+03	1.3849+03	1.3855+03	1.3743+03	1.3538+03
14	1.3372+03	1.3371+03	1.3850+03	1.3855+03	1.3745+03	1.3542+03
15	1.3370+03	1.3372+03	1.3851+03	1.3857+03	1.3747+03	1.3545+03
16	1.1638+03	1.1637+03	1.2203+03	1.2207+03	1.2082+03	1.1856+03
17	1.1639+03	1.1638+03	1.2205+03	1.2207+03	1.2083+03	1.1855+03
18	1.1638+03	1.1636+03	1.2203+03	1.2205+03	1.2082+03	1.1853+03
19	1.0855+03	1.0856+03	1.1379+03	1.1381+03	1.1266+03	1.1061+03
20	1.0854+03	1.0854+03	1.1378+03	1.1380+03	1.1265+03	1.1061+03
21	1.0854+03	1.0854+03	1.1379+03	1.1381+03	1.1266+03	1.1061+03
22	1.0516+03	1.0518+03	1.1290+03	1.1286+03	1.1112+03	1.0794+03
23	1.0520+03	1.0521+03	1.1292+03	1.1289+03	1.1114+03	1.0796+03
24	1.0520+03	1.0521+03	1.1293+03	1.1289+03	1.1115+03	1.0798+03
25	1.2062+03	1.2062+03	1.2794+03	1.2795+03	1.2637+03	1.2347+03
26	1.2063+03	1.2062+03	1.2795+03	1.2796+03	1.2638+03	1.2348+03
27	1.2062+03	1.2061+03	1.2794+03	1.2794+03	1.2636+03	1.2347+03
28	1.2882+03	1.2882+03	1.3721+03	1.3724+03	1.3543+03	1.3210+03
29	1.2884+03	1.2884+03	1.3722+03	1.3725+03	1.3544+03	1.3211+03
30	1.2884+03	1.2884+03	1.3721+03	1.3724+03	1.3543+03	1.3210+03

CONDENSING DATA REDUCTION

	209	211	213	215	217	219
	TC15C	TC16C	TC17C	TC18C	TC19C	TC20C
1	1.1426+03	1.1787+03	1.1750+03	1.1669+03	1.1428+03	1.1416+03
2	1.1424+03	1.1786+03	1.1748+03	1.1668+03	1.1427+03	1.1416+03
3	1.1425+03	1.1786+03	1.1750+03	1.1668+03	1.1427+03	1.1417+03
4	1.1205+03	1.1677+03	1.1630+03	1.1524+03	1.1211+03	1.1197+03
5	1.1206+03	1.1677+03	1.1629+03	1.1525+03	1.1212+03	1.1197+03
6	1.1206+03	1.1678+03	1.1629+03	1.1523+03	1.1211+03	1.1196+03
7	1.1972+03	1.2332+03	1.2294+03	1.2211+03	1.1962+03	1.1952+03
8	1.1972+03	1.2332+03	1.2294+03	1.2211+03	1.1961+03	1.1951+03
9	1.1975+03	1.2335+03	1.2297+03	1.2214+03	1.1965+03	1.1955+03
10	1.2585+03	1.2917+03	1.2883+03	1.2803+03	1.2568+03	1.2562+03
11	1.2587+03	1.2918+03	1.2883+03	1.2804+03	1.2570+03	1.2563+03
12	1.2588+03	1.2921+03	1.2887+03	1.2807+03	1.2572+03	1.2565+03
13	1.3514+03	1.3836+03	1.3807+03	1.3725+03	1.3490+03	1.3484+03
14	1.3518+03	1.3837+03	1.3809+03	1.3728+03	1.3495+03	1.3489+03
15	1.3522+03	1.3840+03	1.3811+03	1.3730+03	1.3497+03	1.3491+03
16	1.1825+03	1.2306+03	1.2255+03	1.2139+03	1.1802+03	1.1787+03
17	1.1825+03	1.2305+03	1.2253+03	1.2137+03	1.1799+03	1.1785+03
18	1.1823+03	1.2304+03	1.2252+03	1.2137+03	1.1799+03	1.1784+03
19	1.1030+03	1.1586+03	1.1532+03	1.1405+03	1.1030+03	1.1010+03
20	1.1030+03	1.1586+03	1.1532+03	1.1405+03	1.1029+03	1.1010+03
21	1.1030+03	1.1588+03	1.1532+03	1.1405+03	1.1029+03	1.1009+03
22	1.0754+03	1.1328+03	1.1262+03	1.1122+03	1.0714+03	1.0695+03
23	1.0757+03	1.1328+03	1.1263+03	1.1122+03	1.0715+03	1.0696+03
24	1.0758+03	1.1331+03	1.1265+03	1.1126+03	1.0717+03	1.0699+03
25	1.2307+03	1.2849+03	1.2794+03	1.2657+03	1.2260+03	1.2244+03
26	1.2308+03	1.2849+03	1.2793+03	1.2656+03	1.2260+03	1.2244+03
27	1.2308+03	1.2850+03	1.2795+03	1.2657+03	1.2260+03	1.2245+03
28	1.3167+03	1.3713+03	1.3660+03	1.3514+03	1.3099+03	1.3086+03
29	1.3170+03	1.3715+03	1.3662+03	1.3514+03	1.3100+03	1.3085+03
30	1.3168+03	1.3714+03	1.3662+03	1.3515+03	1.3100+03	1.3088+03

CONDENSING DATA REDUCTION

	221	223	226	229	230	235
	TKICC	TKOC	TNAO	TNAI	DTNA	WNA
1	1.1901+03	1.1960+03	1.1438+03	1.1320+03	1.1893+01	4.6438+03
2	1.1903+03	1.1960+03	1.1439+03	1.1318+03	1.2120+01	4.6438+03
3	1.1903+03	1.1960+03	1.1438+03	1.1318+03	1.1964+01	4.6438+03
4	1.1932+03	1.1926+03	1.1220+03	1.1068+03	1.5193+01	4.6422+03
5	1.1933+03	1.1924+03	1.1220+03	1.1068+03	1.5278+01	4.6422+03
6	1.1931+03	1.1925+03	1.1219+03	1.1068+03	1.5122+01	4.6422+03
7	1.2432+03	1.2497+03	1.1973+03	1.1842+03	1.3148+01	4.6238+03
8	1.2437+03	1.2500+03	1.1976+03	1.1843+03	1.3292+01	4.6238+03
9	1.2435+03	1.2499+03	1.1977+03	1.1846+03	1.3078+01	4.6238+03
10	1.3027+03	1.3065+03	1.2584+03	1.2453+03	1.3172+01	4.6008+03
11	1.3030+03	1.3066+03	1.2585+03	1.2455+03	1.3088+01	4.6008+03
12	1.3030+03	1.3067+03	1.2585+03	1.2454+03	1.3102+01	4.6008+03
13	1.3979+03	1.3989+03	1.3502+03	1.3365+03	1.3687+01	4.5160+03
14	1.3980+03	1.3991+03	1.3505+03	1.3369+03	1.3617+01	4.5160+03
15	1.3983+03	1.3990+03	1.3508+03	1.3369+03	1.3875+01	4.5160+03
16	1.2449+03	1.2538+03	1.1816+03	1.1637+03	1.7961+01	4.7026+03
17	1.2449+03	1.2536+03	1.1816+03	1.1637+03	1.7947+01	4.7026+03
18	1.2450+03	1.2537+03	1.1816+03	1.1635+03	1.8047+01	4.7026+03
19	1.2139+03	1.1914+03	1.1037+03	1.0854+03	1.8310+01	4.6759+03
20	1.2143+03	1.1914+03	1.1035+03	1.0852+03	1.8279+01	4.6759+03
21	1.2140+03	1.1914+03	1.1036+03	1.0853+03	1.8266+01	4.6759+03
22	1.2536+03	1.1826+03	1.0751+03	1.0516+03	2.3460+01	4.6752+03
23	1.2533+03	1.1828+03	1.0753+03	1.0520+03	2.3335+01	4.6752+03
24	1.2536+03	1.1831+03	1.0756+03	1.0520+03	2.3574+01	4.6752+03
25	1.3024+03	1.3113+03	1.2288+03	1.2060+03	2.2835+01	4.6054+03
26	1.3026+03	1.3113+03	1.2288+03	1.2060+03	2.2835+01	4.6054+03
27	1.3024+03	1.3113+03	1.2287+03	1.2059+03	2.2778+01	4.6054+03
28	1.3939+03	1.3978+03	1.3136+03	1.2879+03	2.5668+01	4.5219+03
29	1.3939+03	1.3978+03	1.3136+03	1.2881+03	2.5468+01	4.5219+03
30	1.3941+03	1.3979+03	1.3136+03	1.2881+03	2.5526+01	4.5219+03

CONDENSING DATA REDUCTION

	237	238	240	243	246	247
	TNAM	CPNA	QNA	DTQL	QC	Q/AA
1	1.1379+03	3.0000-01	1.6569+04	1.0486+03	1.9073+04	6.4764+04
2	1.1379+03	3.0000-01	1.6885+04	1.0490+03	1.9390+04	6.5841+04
3	1.1378+03	3.0000-01	1.6667+04	1.0490+03	1.9172+04	6.5100+04
4	1.1144+03	3.0000-01	2.1159+04	1.0220+03	2.3561+04	8.0002+04
5	1.1144+03	3.0000-01	2.1277+04	1.0220+03	2.3679+04	8.0405+04
6	1.1143+03	3.0000-01	2.1060+04	1.0224+03	2.3463+04	7.9670+04
7	1.1908+03	3.0000-01	1.8238+04	1.1166+03	2.1009+04	7.1338+04
8	1.1910+03	3.0000-01	1.8438+04	1.1169+03	2.1210+04	7.2020+04
9	1.1911+03	3.0000-01	1.8142+04	1.1170+03	2.0914+04	7.1015+04
10	1.2518+03	3.0026-01	1.8197+04	1.1822+03	2.1235+04	7.2104+04
11	1.2520+03	3.0026-01	1.8080+04	1.1828+03	2.1120+04	7.1716+04
12	1.2520+03	3.0026-01	1.8099+04	1.1824+03	2.1138+04	7.1776+04
13	1.3433+03	3.0115-01	1.8614+04	1.2710+03	2.2028+04	7.4799+04
14	1.3437+03	3.0116-01	1.8519+04	1.2714+03	2.1935+04	7.4483+04
15	1.3438+03	3.0116-01	1.8871+04	1.2715+03	2.2287+04	7.5679+04
16	1.1726+03	3.0000-01	2.5340+04	1.1008+03	2.8047+04	9.5236+04
17	1.1726+03	3.0000-01	2.5319+04	1.1012+03	2.8029+04	9.5174+04
18	1.1726+03	3.0000-01	2.5460+04	1.1011+03	2.8169+04	9.5650+04
19	1.0946+03	3.0004-01	2.5688+04	1.0160+03	2.8068+04	9.5306+04
20	1.0944+03	3.0004-01	2.5646+04	1.0158+03	2.8025+04	9.5160+04
21	1.0944+03	3.0004-01	2.5627+04	1.0159+03	2.8006+04	9.5096+04
22	1.0634+03	3.0029-01	3.2935+04	9.8880+02	3.5213+04	1.1957+05
23	1.0636+03	3.0029-01	3.2760+04	9.8908+02	3.5038+04	1.1898+05
24	1.0638+03	3.0029-01	3.3095+04	9.8922+02	3.5374+04	1.2012+05
25	1.2174+03	3.0009-01	3.1559+04	1.1442+03	3.4441+04	1.1695+05
26	1.2174+03	3.0009-01	3.1559+04	1.1442+03	3.4441+04	1.1695+05
27	1.2173+03	3.0009-01	3.1479+04	1.1445+03	3.4363+04	1.1668+05
28	1.3008+03	3.0051-01	3.4880+04	1.2262+03	3.8103+04	1.2938+05
29	1.3008+03	3.0051-01	3.4609+04	1.2263+03	3.7832+04	1.2846+05
30	1.3009+03	3.0051-01	3.4687+04	1.2263+03	3.7910+04	1.2873+05

CONDENSING DATA REDUCTION

	251 WK	306 TWI T	317 Q/A T	319 TWO T	324 HCON T	326 NUC T
1	2.1986+01	1.1764+03	6.2065+04	1.1352+03	5.0751+03	1.4240-02
2	2.2352+01	1.1765+03	6.2349+04	1.1351+03	5.0497+03	1.4169-02
3	2.2101+01	1.1763+03	6.2092+04	1.1351+03	4.9719+03	1.3950-02
4	2.7159+01	1.1597+03	6.9605+04	1.1133+03	2.3919+03	6.7114-03
5	2.7295+01	1.1598+03	6.9465+04	1.1134+03	2.3873+03	6.6986-03
6	2.7046+01	1.1596+03	6.9235+04	1.1134+03	2.3736+03	6.6600-03
7	2.4423+01	1.2369+03	7.3515+04	1.1887+03	1.2672+04	3.5866-02
8	2.4658+01	1.2371+03	7.3913+04	1.1887+03	1.2290+04	3.4787-02
9	2.4314+01	1.2372+03	7.3514+04	1.1891+03	1.2570+04	3.5579-02
10	2.4920+01	1.2997+03	7.8178+04	1.2491+03	2.8774+04	8.2298-02
11	2.4786+01	1.3000+03	7.8444+04	1.2493+03	2.9956+04	8.5682-02
12	2.4807+01	1.3000+03	7.8242+04	1.2494+03	2.9584+04	8.4618-02
13	2.6286+01	1.3955+03	8.6905+04	1.3406+03	4.5325+04	1.3175-01
14	2.6175+01	1.3955+03	8.6196+04	1.3410+03	4.0750+04	1.1845-01
15	2.6596+01	1.3955+03	8.5685+04	1.3414+03	3.8798+04	1.1278-01
16	3.2620+01	1.2331+03	9.0772+04	1.1735+03	8.8377+03	2.5017-02
17	3.2598+01	1.2332+03	9.1018+04	1.1734+03	9.0279+03	2.5555-02
18	3.2762+01	1.2331+03	9.1072+04	1.1733+03	8.8589+03	2.5077-02
19	3.2401+01	1.1496+03	8.1331+04	1.0952+03	1.4949+03	4.2022-03
20	3.2352+01	1.1495+03	8.1084+04	1.0952+03	1.4783+03	4.1556-03
21	3.2330+01	1.1496+03	8.1295+04	1.0952+03	1.4922+03	4.1947-03
22	4.0749+01	1.1478+03	1.2107+05	1.0665+03	1.4270+03	4.0318-03
23	4.0547+01	1.1480+03	1.2100+05	1.0667+03	1.4328+03	4.0481-03
24	4.0938+01	1.1481+03	1.2100+05	1.0668+03	1.4306+03	4.0420-03
25	4.0434+01	1.2960+03	1.1620+05	1.2206+03	2.1835+04	6.2439-02
26	4.0435+01	1.2960+03	1.1626+05	1.2206+03	2.1795+04	6.2327-02
27	4.0342+01	1.2959+03	1.1609+05	1.2206+03	2.1782+04	6.2288-02
28	4.5446+01	1.3912+03	1.3560+05	1.3050+03	7.5498+04	2.1929-01
29	4.5123+01	1.3912+03	1.3539+05	1.3052+03	7.7232+04	2.2433-01
30	4.5217+01	1.3911+03	1.3549+05	1.3050+03	6.9404+04	2.0159-01

CONDENSING DATA REDUCTION

	354	365	367	372	374	389
	TWI B	Q/A B	TWO B	HCON B	NUC B	TWI TC
1	1.1886+03	7.3113+04	1.1402+03	1.3704+04	3.8470-02	1.1788+03
2	1.1884+03	7.2968+04	1.1401+03	1.3034+04	3.6591-02	1.1788+03
3	1.1885+03	7.2965+04	1.1402+03	1.3271+04	3.7257-02	1.1786+03
4	1.1816+03	9.6303+04	1.1175+03	9.5904+03	2.6917-02	1.1620+03
5	1.1815+03	9.6024+04	1.1176+03	9.6245+03	2.7012-02	1.1620+03
6	1.1815+03	9.6276+04	1.1175+03	9.6829+03	2.7176-02	1.1619+03
7	1.2436+03	7.7186+04	1.1931+03	1.9371+04	5.4873-02	1.2395+03
8	1.2436+03	7.7245+04	1.1930+03	1.7859+04	5.0594-02	1.2397+03
9	1.2438+03	7.7048+04	1.1934+03	1.9023+04	5.3889-02	1.2398+03
10	1.3014+03	7.4060+04	1.2535+03	2.0214+04	5.7840-02	1.3025+03
11	1.3013+03	7.3857+04	1.2536+03	1.9282+04	5.5175-02	1.3029+03
12	1.3017+03	7.4119+04	1.2539+03	2.1216+04	6.0710-02	1.3029+03
13	1.3935+03	7.6907+04	1.3449+03	1.7669+04	5.1363-02	1.3987+03
14	1.3935+03	7.6066+04	1.3454+03	1.6892+04	4.9106-02	1.3987+03
15	1.3937+03	7.6137+04	1.3456+03	1.7940+04	5.2152-02	1.3988+03
16	1.2458+03	1.0688+05	1.1757+03	2.1779+04	6.1729-02	1.2357+03
17	1.2457+03	1.0711+05	1.1754+03	2.2361+04	6.3378-02	1.2358+03
18	1.2456+03	1.0709+05	1.1754+03	2.1418+04	6.0705-02	1.2357+03
19	1.1760+03	1.1637+05	1.0984+03	6.1074+03	1.7147-02	1.1519+03
20	1.1761+03	1.1644+05	1.0984+03	6.1019+03	1.7132-02	1.1517+03
21	1.1762+03	1.1676+05	1.0983+03	6.1541+03	1.7279-02	1.1519+03
22	1.1517+03	1.2670+05	1.0666+03	2.7946+03	7.8477-03	1.1501+03
23	1.1517+03	1.2664+05	1.0667+03	2.7911+03	7.8380-03	1.1503+03
24	1.1520+03	1.2664+05	1.0670+03	2.7925+03	7.8420-03	1.1504+03
25	1.3036+03	1.2864+05	1.2202+03	2.8527+04	8.1671-02	1.2989+03
26	1.3035+03	1.2847+05	1.2202+03	2.7475+04	7.8662-02	1.2990+03
27	1.3037+03	1.2874+05	1.2202+03	2.9348+04	8.4021-02	1.2988+03
28	1.3911+03	1.3829+05	1.3032+03	2.9819+04	8.6652-02	1.3945+03
29	1.3914+03	1.3879+05	1.3031+03	3.1595+04	9.1814-02	1.3945+03
30	1.3913+03	1.3832+05	1.3033+03	2.9893+04	8.6870-02	1.3945+03

CONDENSING DATA REDUCTION

	399 Q/A TC	401 TWO TC	405 TKC-TW	406 HCONTC	408 NUC TC	424 TWI BC
1	5.6217+04	1.1415+03	1.2612+01	4.4574+03	1.2510-02	1.1920+03
2	5.6504+04	1.1413+03	1.2822+01	4.4067+03	1.2368-02	1.1918+03
3	5.6246+04	1.1414+03	1.2897+01	4.3613+03	1.2241-02	1.1919+03
*4	6.4091+04	1.1193+03	3.1042+01	2.0646+03	5.7955-03	1.1850+03
*5	6.3949+04	1.1194+03	3.1081+01	2.0575+03	5.7756-03	1.1849+03
*6	6.3718+04	1.1194+03	3.1076+01	2.0504+03	5.7555-03	1.1850+03
7	6.7071+04	1.1956+03	5.1246+00	1.3088+04	3.7056-02	1.2469+03
8	6.7472+04	1.1956+03	5.3654+00	1.2575+04	3.5608-02	1.2469+03
9	6.7066+04	1.1959+03	5.1449+00	1.3036+04	3.6910-02	1.2472+03
10	7.0981+04	1.2567+03	1.0125+00	7.0107+04	2.0056-01	1.3047+03
11	7.1247+04	1.2569+03	8.9740-01	7.9393+04	2.2713-01	1.3047+03
12	7.1042+04	1.2570+03	9.2558-01	7.6754+04	2.1958-01	1.3050+03
13	7.8536+04	1.3492+03	-6.4943-01	-1.2093+05	-3.5155-01	1.3968+03
14	7.7816+04	1.3496+03	-4.5531-01	-1.7091+05	-4.9685-01	1.3968+03
15	7.7295+04	1.3500+03	-3.4555-01	-2.2369+05	-6.5030-01	1.3970+03
16	8.4657+04	1.1802+03	1.1208+01	7.5530+03	2.1394-02	1.2492+03
17	8.4905+04	1.1801+03	1.1012+01	7.7100+03	2.1838-02	1.2491+03
18	8.4962+04	1.1800+03	1.1247+01	7.5542+03	2.1397-02	1.2490+03
*19	7.6133+04	1.1010+03	5.7049+01	1.3345+03	3.7546-03	1.1795+03
*20	7.5884+04	1.1010+03	5.7459+01	1.3207+03	3.7158-03	1.1795+03
*21	7.6095+04	1.1010+03	5.7095+01	1.3328+03	3.7497-03	1.1797+03
*22	1.1652+05	1.0719+03	8.7710+01	1.3284+03	3.7567-03	1.1552+03
*23	1.1644+05	1.0722+03	8.7277+01	1.3341+03	3.7726-03	1.1552+03
*24	1.1643+05	1.0723+03	8.7500+01	1.3307+03	3.7631-03	1.1555+03
25	1.0968+05	1.2278+03	5.5507+00	1.9759+04	5.6534-02	1.3070+03
26	1.0973+05	1.2279+03	5.5588+00	1.9740+04	5.6481-02	1.3069+03
27	1.0956+05	1.2278+03	5.5453+00	1.9758+04	5.6530-02	1.3071+03
28	1.2811+05	1.3132+03	3.0226-01	4.2385+05	1.2315+00	1.3945+03
29	1.2790+05	1.3134+03	2.3526-01	5.4366+05	1.5796+00	1.3948+03
30	1.2801+05	1.3132+03	4.3967-01	2.9114+05	8.4592-01	1.3947+03

*Subcooled liquid at test section outlet, therefore calculational
procedure not valid. Not plotted in Figure 20.

CONDENSING DATA REDUCTION

	434 Q/A BC	436 TWO BC	439 TK-TWI	440 HCONBC	442 NUC BC	450 PSI HD
1	8.0450+04	1.1387+03	2.6751+00	3.0073+04	8.4431-02	6.6014-01
2	8.0305+04	1.1386+03	2.9648+00	2.7086+04	7.6045-02	6.8108-01
3	8.0300+04	1.1387+03	2.8450+00	2.8225+04	7.9241-02	6.6620-01
*4	1.0401+05	1.1158+03	7.7417+00	1.3436+04	3.7713-02	9.8805-01
*5	1.0373+05	1.1159+03	7.6886+00	1.3492+04	3.7871-02	9.9715-01
*6	1.0399+05	1.1158+03	7.6319+00	1.3626+04	3.8246-02	9.8036-01
7	8.3844+04	1.1921+03	1.3064+00	6.4180+04	1.8183-01	5.9613-01
8	8.3903+04	1.1920+03	1.6564+00	5.0655+04	1.4352-01	6.0589-01
9	8.3700+04	1.1924+03	1.3662+00	6.1266+04	1.7358-01	5.8962-01
10	7.9889+04	1.2531+03	1.0043+00	7.9545+04	2.2764-01	4.4788-01
11	7.9684+04	1.2532+03	1.1674+00	6.8260+04	1.9535-01	4.4243-01
12	7.9943+04	1.2534+03	8.3080-01	9.6225+04	2.7538-01	4.4317-01
13	8.1473+04	1.3453+03	1.9262+00	4.2298+04	1.2298-01	3.0919-01
14	8.0621+04	1.3458+03	2.0773+00	3.8810+04	1.1284-01	3.0636-01
15	8.0689+04	1.3461+03	1.8225+00	4.4274+04	1.2872-01	3.1593-01
16	1.1388+05	1.1745+03	2.6413+00	4.3116+04	1.2223-01	1.0529+00
17	1.1411+05	1.1743+03	2.5205+00	4.5274+04	1.2834-01	1.0515+00
18	1.1409+05	1.1742+03	2.7417+00	4.1614+04	1.1797-01	1.0616+00
*19	1.2440+05	1.0965+03	1.6895+01	7.3633+03	2.0676-02	1.2425+00
*20	1.2447+05	1.0965+03	1.6912+01	7.3597+03	2.0666-02	1.2362+00
*21	1.2479+05	1.0964+03	1.6805+01	7.4260+03	2.0852-02	1.2367+00
*22	1.3516+05	1.0644+03	4.3195+01	3.1291+03	8.7883-03	1.5646+00
*23	1.3511+05	1.0645+03	4.3222+01	3.1259+03	8.7792-03	1.5522+00
*24	1.3511+05	1.0648+03	4.3229+01	3.1253+03	8.7780-03	1.5793+00
25	1.3512+05	1.2194+03	2.3108+00	5.8473+04	1.6744-01	1.1806+00
26	1.3495+05	1.2194+03	2.4767+00	5.4490+04	1.5604-01	1.1798+00
27	1.3522+05	1.2195+03	2.1841+00	6.1912+04	1.7729-01	1.1756+00
28	1.4367+05	1.3032+03	2.3954+00	5.9975+04	1.7432-01	9.4154-01
29	1.4417+05	1.3032+03	2.1424+00	6.7293+04	1.9559-01	9.2834-01
30	1.4370+05	1.3034+03	2.3801+00	6.0375+04	1.7548-01	9.3161-01

*Subcooled liquid at test section outlet, therefore calculational procedure not valid. Not plotted in Figure 20.

CONDENSING DATA REDUCTION

	451	452	453	610	611	613
	PI	PO	DPC	PIC	POC	DPCC
1	4.3932+00	4.6766+00	-2.8340-01	4.4939+00	4.6739+00	-1.7998-01
2	4.3981+00	4.6778+00	-2.7979-01	4.5027+00	4.6752+00	-1.7247-01
3	4.3981+00	4.6778+00	-2.7979-01	4.5001+00	4.6752+00	-1.7512-01
4	4.4275+00	4.5745+00	-1.4700-01	4.5889+00	4.5713+00	1.7556-02
5	4.4299+00	4.5680+00	-1.3809-01	4.5930+00	4.5648+00	2.8248-02
6	4.4262+00	4.5699+00	-1.4370-01	4.5862+00	4.5668+00	1.9420-02
7	6.2034+00	6.5435+00	-3.4009-01	6.2976+00	6.5506+00	-2.5296-01
8	6.2217+00	6.5552+00	-3.3342-01	6.3174+00	6.5623+00	-2.4491-01
9	6.2184+00	6.5543+00	-3.3592-01	6.3113+00	6.5615+00	-2.5016-01
10	8.8905+00	9.1363+00	-2.4586-01	8.9603+00	9.1605+00	-2.0010-01
11	8.9060+00	9.1419+00	-2.3589-01	8.9749+00	9.1660+00	-1.9116-01
12	8.9060+00	9.1441+00	-2.3811-01	8.9750+00	9.1682+00	-1.9326-01
13	1.4966+01	1.5023+01	-5.7085-02	1.5013+01	1.5094+01	-8.0385-02
14	1.4979+01	1.5035+01	-5.5501-02	1.5026+01	1.5105+01	-7.9352-02
15	1.4995+01	1.5030+01	-3.4143-02	1.5044+01	1.5100+01	-5.6413-02
16	6.1901+00	6.7123+00	-5.2225-01	6.3659+00	6.7206+00	-3.5467-01
17	6.1901+00	6.7009+00	-5.1087-01	6.3656+00	6.7091+00	-3.4348-01
18	6.1917+00	6.7071+00	-5.1533-01	6.3691+00	6.7153+00	-3.4618-01
19	5.0372+00	4.5383+00	4.9895-01	5.2459+00	4.5349+00	7.1098-01
20	5.0495+00	4.5370+00	5.1250-01	5.2572+00	4.5336+00	7.2364-01
21	5.0400+00	4.5396+00	5.0039-01	5.2475+00	4.5362+00	7.1136-01
22	6.4418+00	4.2841+00	2.1577+00	6.7114+00	4.2797+00	2.4317+00
23	6.4301+00	4.2896+00	2.1405+00	6.6972+00	4.2853+00	2.4119+00
24	6.4385+00	4.2976+00	2.1409+00	6.7109+00	4.2933+00	2.4176+00
25	8.7499+00	9.3841+00	-6.3425-01	8.9487+00	9.4106+00	-4.6194-01
26	8.7562+00	9.3864+00	-6.3022-01	8.9550+00	9.4129+00	-4.5790-01
27	8.7478+00	9.3818+00	-6.3405-01	8.9456+00	9.4083+00	-4.6273-01
28	1.4555+01	1.4937+01	-3.8205-01	1.4715+01	1.5007+01	-2.9234-01
29	1.4555+01	1.4937+01	-3.8204-01	1.4713+01	1.5007+01	-2.9474-01
30	1.4565+01	1.4949+01	-3.8373-01	1.4723+01	1.5019+01	-2.9599-01

CONDENSING DATA REDUCTION

	700	495	701	498	504	507
	X B	WKL B	X T	WKL T	NREF T	NREF B
1	2.6578-01	1.6143+01	8.1878-01	3.9843+00	4.5304+02	1.8393+03
2	2.6470-01	1.6436+01	8.1778-01	4.0731+00	4.6320+02	1.8728+03
3	2.6489-01	1.6247+01	8.1797-01	4.0231+00	4.5750+02	1.8513+03
4	2.3800-01	2.0695+01	7.9302-01	5.6214+00	6.3986+02	2.3552+03
5	2.3734-01	2.0817+01	7.9239-01	5.6668+00	6.4505+02	2.3688+03
6	2.3779-01	2.0615+01	7.9282-01	5.6033+00	6.3776+02	2.3458+03
7	2.6963-01	1.7838+01	8.2216-01	4.3433+00	5.1003+02	2.0990+03
8	2.6867-01	1.8033+01	8.2128-01	4.4068+00	5.1762+02	2.1224+03
9	2.6923-01	1.7768+01	8.2180-01	4.3326+00	5.0887+02	2.0911+03
10	2.5966-01	1.8449+01	8.1303-01	4.6593+00	5.6552+02	2.2421+03
11	2.5872-01	1.8374+01	8.1218-01	4.6555+00	5.6514+02	2.2331+03
12	2.5890-01	1.8384+01	8.1234-01	4.6552+00	5.6511+02	2.2345+03
13	2.4788-01	1.9770+01	8.0219-01	5.1995+00	6.6361+02	2.5240+03
14	2.4782-01	1.9688+01	8.0213-01	5.1792+00	6.6108+02	2.5139+03
15	2.4723-01	2.0021+01	8.0157-01	5.2773+00	6.7367+02	2.5563+03
16	2.6933-01	2.3834+01	8.2190-01	5.8095+00	6.8311+02	2.8106+03
17	2.6844-01	2.3848+01	8.2109-01	5.8321+00	6.8573+02	2.8118+03
18	2.6863-01	2.3961+01	8.2126-01	5.8558+00	6.8856+02	2.8254+03
19	2.2300-01	2.5175+01	7.7856-01	7.1748+00	8.2491+02	2.8717+03
20	2.2316-01	2.5132+01	7.7872-01	7.1588+00	8.2320+02	2.8668+03
21	2.2302-01	2.5120+01	7.7858-01	7.1584+00	8.2305+02	2.8654+03
22	2.7489-01	2.9548+01	8.3356-01	6.7825+00	7.9336+02	3.3746+03
23	2.7438-01	2.9422+01	8.3299-01	6.7717+00	7.9199+02	3.3603+03
24	2.7340-01	2.9746+01	8.3194-01	6.8802+00	8.0482+02	3.3979+03
25	2.6649-01	2.9659+01	8.1921-01	7.3100+00	8.8772+02	3.6123+03
26	2.6623-01	2.9670+01	8.1897-01	7.3198+00	8.8896+02	3.6138+03
27	2.6646-01	2.9592+01	8.1919-01	7.2943+00	8.8577+02	3.6041+03
28	2.5415-01	3.3896+01	8.0791-01	8.7298+00	1.1122+03	4.3234+03
29	2.5405-01	3.3659+01	8.0782-01	8.6715+00	1.1047+03	4.2932+03
30	2.5410-01	3.3727+01	8.0787-01	8.6875+00	1.1069+03	4.3022+03

CONDENSING DATA REDUCTION

	131	132	134	138	140	142
	DATE	TIME	TC1	TC3	TC4	TC5
1	1.1250+03	8.0000+02	1.4016+03	1.4161+03	1.4042+03	1.2941+03
2	1.1250+03	8.0000+02	1.4016+03	1.4161+03	1.4043+03	1.2941+03
3	1.1250+03	8.0000+02	1.4015+03	1.4159+03	1.4039+03	1.2941+03
4	1.1250+03	1.4450+03	1.3020+03	1.3221+03	1.3111+03	1.2146+03
5	1.1250+03	1.4450+03	1.3023+03	1.3222+03	1.3110+03	1.2147+03
6	1.1250+03	1.4450+03	1.3015+03	1.3224+03	1.3113+03	1.2147+03
7	1.1250+03	1.6300+03	1.3026+03	1.3194+03	1.3089+03	1.1951+03
8	1.1250+03	1.6300+03	1.3030+03	1.3193+03	1.3087+03	1.1950+03
9	1.1250+03	1.6300+03	1.3028+03	1.3194+03	1.3088+03	1.1950+03
*10	1.1250+03	2.0300+03	1.3103+03	1.2409+03	1.2311+03	1.0873+03
*11	1.1250+03	2.0300+03	1.3102+03	1.2402+03	1.2305+03	1.0866+03
*12	1.1250+03	2.0300+03	1.3102+03	1.2399+03	1.2302+03	1.0863+03
13	1.1350+03	2.4000+02	1.4084+03	1.4245+03	1.4123+03	1.2726+03
14	1.1350+03	2.4000+02	1.4087+03	1.4244+03	1.4121+03	1.2728+03
15	1.1350+03	2.4000+02	1.4085+03	1.4246+03	1.4122+03	1.2729+03
*16	1.1350+03	4.4500+02	1.4053+03	1.4079+03	1.3958+03	1.2081+03
*17	1.1350+03	4.4500+02	1.4053+03	1.4077+03	1.3956+03	1.2079+03
*18	1.1350+03	4.4500+02	1.4051+03	1.4073+03	1.3953+03	1.2075+03
19	1.1350+03	1.6000+03	1.3549+03	1.3733+03	1.3614+03	1.2388+03
20	1.1350+03	1.6000+03	1.3547+03	1.3732+03	1.3615+03	1.2385+03
21	1.1350+03	1.6000+03	1.3547+03	1.3733+03	1.3614+03	1.2385+03
22	1.1350+03	2.0000+03	1.3551+03	1.3697+03	1.3587+03	1.2711+03
23	1.1350+03	2.0000+03	1.3550+03	1.3697+03	1.3587+03	1.2708+03
24	1.1350+03	2.0000+03	1.3550+03	1.3697+03	1.3587+03	1.2709+03
25	1.1350+03	2.2450+03	1.3556+03	1.3641+03	1.3531+03	1.2988+03
26	1.1350+03	2.2450+03	1.3559+03	1.3641+03	1.3531+03	1.2990+03
27	1.1350+03	2.2450+03	1.3558+03	1.3644+03	1.3534+03	1.2991+03
28	1.1450+03	3.0000+01	1.3012+03	1.3135+03	1.3033+03	1.2447+03
29	1.1450+03	3.0000+01	1.3016+03	1.3134+03	1.3033+03	1.2448+03
30	1.1450+03	3.0000+01	1.3014+03	1.3133+03	1.3032+03	1.2446+03

* Subcooled liquid at test section outlet, therefore calculational
  procedure not valid. Not plotted in Figure 20.

CONDENSING DATA REDUCTION

	144 TC6	146 TC7	148 TC8	150 TC9	152 TC10	154 TC11
1	1.2947+03	1.2806+03	1.2615+03	1.2633+03	1.2626+03	1.3578+03
2	1.2946+03	1.2805+03	1.2614+03	1.2632+03	1.2626+03	1.3577+03
3	1.2945+03	1.2804+03	1.2614+03	1.2635+03	1.2626+03	1.3573+03
4	1.2150+03	1.2017+03	1.1891+03	1.1903+03	1.1903+03	1.2615+03
5	1.2150+03	1.2017+03	1.1889+03	1.1902+03	1.1902+03	1.2615+03
6	1.2150+03	1.2018+03	1.1889+03	1.1904+03	1.1903+03	1.2616+03
7	1.1954+03	1.1823+03	1.1650+03	1.1664+03	1.1664+03	1.2515+03
8	1.1954+03	1.1821+03	1.1649+03	1.1662+03	1.1664+03	1.2515+03
9	1.1952+03	1.1822+03	1.1649+03	1.1662+03	1.1661+03	1.2514+03
10	1.0875+03	1.0758+03	1.0518+03	1.0530+03	1.0531+03	1.1697+03
11	1.0866+03	1.0750+03	1.0512+03	1.0525+03	1.0527+03	1.1693+03
12	1.0865+03	1.0747+03	1.0509+03	1.0521+03	1.0522+03	1.1685+03
13	1.2728+03	1.2593+03	1.2297+03	1.2315+03	1.2313+03	1.3584+03
14	1.2729+03	1.2594+03	1.2295+03	1.2311+03	1.2310+03	1.3584+03
15	1.2728+03	1.2593+03	1.2295+03	1.2311+03	1.2310+03	1.3583+03
16	1.2075+03	1.1952+03	1.1509+03	1.1526+03	1.1525+03	1.3229+03
17	1.2074+03	1.1950+03	1.1504+03	1.1523+03	1.1522+03	1.3206+03
18	1.2069+03	1.1944+03	1.1506+03	1.1521+03	1.1524+03	1.3217+03
19	1.2388+03	1.2257+03	1.2029+03	1.2044+03	1.2044+03	1.3095+03
20	1.2386+03	1.2256+03	1.2026+03	1.2041+03	1.2042+03	1.3096+03
21	1.2385+03	1.2253+03	1.2027+03	1.2042+03	1.2042+03	1.3093+03
22	1.2712+03	1.2574+03	1.2459+03	1.2475+03	1.2476+03	1.3172+03
23	1.2710+03	1.2576+03	1.2463+03	1.2476+03	1.2478+03	1.3172+03
24	1.2712+03	1.2576+03	1.2463+03	1.2476+03	1.2478+03	1.3174+03
25	1.2996+03	1.2856+03	1.2851+03	1.2864+03	1.2865+03	1.3239+03
26	1.2998+03	1.2856+03	1.2851+03	1.2868+03	1.2868+03	1.3240+03
27	1.3000+03	1.2859+03	1.2855+03	1.2867+03	1.2869+03	1.3240+03
28	1.2455+03	1.2318+03	1.2300+03	1.2313+03	1.2314+03	1.2702+03
29	1.2455+03	1.2318+03	1.2300+03	1.2312+03	1.2313+03	1.2703+03
30	1.2453+03	1.2318+03	1.2298+03	1.2311+03	1.2313+03	1.2702+03

CONDENSING DATA REDUCTION

	156	158	160	162	164	166
	TC12	TC13	TC14	TC15	TC16	TC17
1	1.3820+03	1.3542+03	1.3057+03	1.2862+03	1.3656+03	1.3677+03
2	1.3819+03	1.3541+03	1.3056+03	1.2862+03	1.3657+03	1.3678+03
3	1.3819+03	1.3541+03	1.3055+03	1.2862+03	1.3656+03	1.3679+03
4	1.2832+03	1.2616+03	1.2239+03	1.2061+03	1.2762+03	1.2797+03
5	1.2832+03	1.2616+03	1.2240+03	1.2062+03	1.2764+03	1.2799+03
6	1.2833+03	1.2617+03	1.2239+03	1.2061+03	1.2761+03	1.2797+03
7	1.2729+03	1.2486+03	1.2056+03	1.1873+03	1.2669+03	1.2683+03
8	1.2731+03	1.2486+03	1.2057+03	1.1874+03	1.2670+03	1.2683+03
9	1.2728+03	1.2484+03	1.2055+03	1.1872+03	1.2668+03	1.2682+03
10	1.1899+03	1.1570+03	1.0995+03	1.0813+03	1.1636+03	1.1638+03
11	1.1893+03	1.1565+03	1.0990+03	1.0810+03	1.1630+03	1.1632+03
12	1.1887+03	1.1560+03	1.0986+03	1.0805+03	1.1625+03	1.1626+03
13	1.3819+03	1.3479+03	1.2875+03	1.2669+03	1.3637+03	1.3641+03
14	1.3819+03	1.3480+03	1.2876+03	1.2669+03	1.3636+03	1.3640+03
15	1.3817+03	1.3478+03	1.2874+03	1.2668+03	1.3636+03	1.3641+03
16	1.3450+03	1.3019+03	1.2261+03	1.2040+03	1.3282+03	1.3258+03
17	1.3426+03	1.3006+03	1.2255+03	1.2033+03	1.3270+03	1.3247+03
18	1.3438+03	1.3009+03	1.2253+03	1.2032+03	1.3275+03	1.3252+03
19	1.3322+03	1.3029+03	1.2515+03	1.2320+03	1.3182+03	1.3194+03
20	1.3324+03	1.3029+03	1.2514+03	1.2319+03	1.3182+03	1.3193+03
21	1.3321+03	1.3027+03	1.2512+03	1.2316+03	1.3182+03	1.3191+03
22	1.3399+03	1.3181+03	1.2800+03	1.2619+03	1.3277+03	1.3315+03
23	1.3399+03	1.3181+03	1.2801+03	1.2619+03	1.3276+03	1.3313+03
24	1.3401+03	1.3182+03	1.2801+03	1.2620+03	1.3277+03	1.3314+03
25	1.3466+03	1.3315+03	1.3051+03	1.2882+03	1.3330+03	1.3391+03
26	1.3465+03	1.3317+03	1.3052+03	1.2883+03	1.3330+03	1.3391+03
27	1.3467+03	1.3316+03	1.3052+03	1.2883+03	1.3330+03	1.3391+03
28	1.2917+03	1.2769+03	1.2508+03	1.2343+03	1.2813+03	1.2868+03
29	1.2917+03	1.2770+03	1.2507+03	1.2343+03	1.2812+03	1.2867+03
30	1.2917+03	1.2770+03	1.2509+03	1.2344+03	1.2812+03	1.2866+03

CONDENSING DATA REDUCTION

	168	170	172	174	176	181
	TC18	TC19	TC20	TKI	TKO	TC1C
1	1.3499+03	1.2914+03	1.2873+03	1.4016+03	1.4101+03	1.4016+03
2	1.3499+03	1.2912+03	1.2873+03	1.4016+03	1.4102+03	1.4016+03
3	1.3499+03	1.2912+03	1.2874+03	1.4015+03	1.4099+03	1.4015+03
4	1.2646+03	1.2144+03	1.2109+03	1.3020+03	1.3166+03	1.3020+03
5	1.2647+03	1.2145+03	1.2110+03	1.3023+03	1.3166+03	1.3023+03
6	1.2647+03	1.2144+03	1.2110+03	1.3015+03	1.3169+03	1.3015+03
7	1.2509+03	1.1938+03	1.1902+03	1.3026+03	1.3142+03	1.3026+03
8	1.2509+03	1.1938+03	1.1902+03	1.3030+03	1.3140+03	1.3030+03
9	1.2507+03	1.1937+03	1.1900+03	1.3028+03	1.3141+03	1.3028+03
10	1.1442+03	1.0834+03	1.0795+03	1.3103+03	1.2360+03	1.3103+03
11	1.1437+03	1.0829+03	1.0793+03	1.3102+03	1.2353+03	1.3102+03
12	1.1430+03	1.0825+03	1.0786+03	1.3102+03	1.2350+03	1.3102+03
13	1.3406+03	1.2676+03	1.2632+03	1.4084+03	1.4184+03	1.4084+03
14	1.3405+03	1.2676+03	1.2630+03	1.4087+03	1.4183+03	1.4087+03
15	1.3406+03	1.2676+03	1.2633+03	1.4085+03	1.4184+03	1.4085+03
16	1.2947+03	1.2001+03	1.1950+03	1.4053+03	1.4018+03	1.4053+03
17	1.2938+03	1.1999+03	1.1945+03	1.4053+03	1.4016+03	1.4053+03
18	1.2941+03	1.1999+03	1.1946+03	1.4051+03	1.4013+03	1.4051+03
19	1.2994+03	1.2359+03	1.2318+03	1.3549+03	1.3673+03	1.3549+03
20	1.2994+03	1.2354+03	1.2315+03	1.3547+03	1.3673+03	1.3547+03
21	1.2991+03	1.2354+03	1.2317+03	1.3547+03	1.3673+03	1.3547+03
22	1.3172+03	1.2703+03	1.2670+03	1.3551+03	1.3642+03	1.3551+03
23	1.3171+03	1.2702+03	1.2669+03	1.3550+03	1.3642+03	1.3550+03
24	1.3172+03	1.2700+03	1.2668+03	1.3550+03	1.3642+03	1.3550+03
25	1.3308+03	1.3005+03	1.2977+03	1.3556+03	1.3586+03	1.3556+03
26	1.3309+03	1.3007+03	1.2979+03	1.3559+03	1.3586+03	1.3559+03
27	1.3309+03	1.3006+03	1.2979+03	1.3558+03	1.3589+03	1.3558+03
28	1.2778+03	1.2460+03	1.2433+03	1.3012+03	1.3084+03	1.3012+03
29	1.2777+03	1.2459+03	1.2433+03	1.3016+03	1.3084+03	1.3016+03
30	1.2776+03	1.2459+03	1.2432+03	1.3014+03	1.3082+03	1.3014+03

CONDENSING DATA REDUCTION

	185	187	189	191	193	195
	TC3C	TC4C	TC5C	TC6C	TC7C	TC8C
1	1.4122+03	1.4101+03	1.2974+03	1.2968+03	1.2973+03	1.2615+03
2	1.4122+03	1.4101+03	1.2974+03	1.2967+03	1.2972+03	1.2614+03
3	1.4120+03	1.4098+03	1.2974+03	1.2966+03	1.2970+03	1.2614+03
4	1.3182+03	1.3161+03	1.2177+03	1.2169+03	1.2174+03	1.1891+03
5	1.3183+03	1.3159+03	1.2178+03	1.2170+03	1.2174+03	1.1889+03
6	1.3185+03	1.3163+03	1.2179+03	1.2170+03	1.2175+03	1.1889+03
7	1.3155+03	1.3138+03	1.1981+03	1.1974+03	1.1978+03	1.1650+03
8	1.3153+03	1.3137+03	1.1981+03	1.1974+03	1.1976+03	1.1649+03
9	1.3155+03	1.3137+03	1.1981+03	1.1971+03	1.1977+03	1.1649+03
10	1.2369+03	1.2352+03	1.0901+03	1.0892+03	1.0900+03	1.0518+03
11	1.2363+03	1.2346+03	1.0894+03	1.0883+03	1.0892+03	1.0512+03
12	1.2360+03	1.2343+03	1.0891+03	1.0882+03	1.0889+03	1.0509+03
13	1.4206+03	1.4182+03	1.2759+03	1.2749+03	1.2757+03	1.2297+03
14	1.4205+03	1.4181+03	1.2760+03	1.2750+03	1.2759+03	1.2295+03
15	1.4207+03	1.4182+03	1.2761+03	1.2748+03	1.2757+03	1.2295+03
16	1.4040+03	1.4016+03	1.2112+03	1.2095+03	1.2108+03	1.1509+03
17	1.4037+03	1.4014+03	1.2110+03	1.2093+03	1.2106+03	1.1504+03
18	1.4034+03	1.4011+03	1.2106+03	1.2089+03	1.2101+03	1.1506+03
19	1.3694+03	1.3669+03	1.2419+03	1.2409+03	1.2417+03	1.2029+03
20	1.3693+03	1.3669+03	1.2417+03	1.2406+03	1.2416+03	1.2026+03
21	1.3694+03	1.3669+03	1.2417+03	1.2405+03	1.2414+03	1.2027+03
22	1.3657+03	1.3641+03	1.2743+03	1.2732+03	1.2738+03	1.2459+03
23	1.3657+03	1.3641+03	1.2741+03	1.2731+03	1.2740+03	1.2463+03
24	1.3658+03	1.3641+03	1.2741+03	1.2733+03	1.2740+03	1.2463+03
25	1.3601+03	1.3585+03	1.3021+03	1.3017+03	1.3023+03	1.2851+03
26	1.3602+03	1.3585+03	1.3023+03	1.3019+03	1.3023+03	1.2851+03
27	1.3605+03	1.3588+03	1.3024+03	1.3022+03	1.3026+03	1.2855+03
28	1.3095+03	1.3082+03	1.2479+03	1.2475+03	1.2479+03	1.2300+03
29	1.3095+03	1.3082+03	1.2480+03	1.2475+03	1.2479+03	1.2300+03
30	1.3094+03	1.3080+03	1.2478+03	1.2473+03	1.2478+03	1.2298+03

CONDENSING DATA REDUCTION

	197 TC9C	199 TC10C	201 TC11C	203 TC12C	205 TC13C	207 TC14C
1	1.2627+03	1.2620+03	1.3768+03	1.3774+03	1.3525+03	1.3076+03
2	1.2625+03	1.2620+03	1.3767+03	1.3773+03	1.3524+03	1.3075+03
3	1.2628+03	1.2621+03	1.3763+03	1.3773+03	1.3523+03	1.3074+03
4	1.1897+03	1.1896+03	1.2787+03	1.2788+03	1.2596+03	1.2253+03
5	1.1895+03	1.1895+03	1.2787+03	1.2788+03	1.2597+03	1.2254+03
6	1.1897+03	1.1896+03	1.2789+03	1.2790+03	1.2597+03	1.2253+03
7	1.1657+03	1.1657+03	1.2686+03	1.2686+03	1.2466+03	1.2069+03
8	1.1656+03	1.1657+03	1.2686+03	1.2687+03	1.2467+03	1.2069+03
9	1.1655+03	1.1655+03	1.2685+03	1.2685+03	1.2464+03	1.2067+03
10	1.0523+03	1.0523+03	1.1853+03	1.1857+03	1.1548+03	1.0999+03
11	1.0517+03	1.0519+03	1.1849+03	1.1851+03	1.1543+03	1.0995+03
12	1.0514+03	1.0515+03	1.1841+03	1.1845+03	1.1538+03	1.0991+03
13	1.2308+03	1.2307+03	1.3774+03	1.3773+03	1.3462+03	1.2893+03
14	1.2305+03	1.2304+03	1.3775+03	1.3774+03	1.3463+03	1.2893+03
15	1.2305+03	1.2304+03	1.3773+03	1.3772+03	1.3460+03	1.2892+03
16	1.1519+03	1.1519+03	1.3413+03	1.3405+03	1.3001+03	1.2274+03
17	1.1516+03	1.1516+03	1.3390+03	1.3382+03	1.2987+03	1.2269+03
18	1.1514+03	1.1517+03	1.3400+03	1.3394+03	1.2990+03	1.2267+03
19	1.2037+03	1.2038+03	1.3276+03	1.3277+03	1.3010+03	1.2530+03
20	1.2034+03	1.2036+03	1.3277+03	1.3279+03	1.3011+03	1.2529+03
21	1.2035+03	1.2036+03	1.3275+03	1.3276+03	1.3009+03	1.2527+03
22	1.2469+03	1.2471+03	1.3355+03	1.3354+03	1.3163+03	1.2818+03
23	1.2470+03	1.2472+03	1.3355+03	1.3354+03	1.3163+03	1.2819+03
24	1.2470+03	1.2472+03	1.3356+03	1.3356+03	1.3164+03	1.2818+03
25	1.2858+03	1.2860+03	1.3423+03	1.3421+03	1.3297+03	1.3070+03
26	1.2861+03	1.2863+03	1.3424+03	1.3420+03	1.3299+03	1.3071+03
27	1.2861+03	1.2863+03	1.3424+03	1.3422+03	1.3298+03	1.3071+03
28	1.2306+03	1.2308+03	1.2877+03	1.2873+03	1.2750+03	1.2523+03
29	1.2305+03	1.2307+03	1.2877+03	1.2873+03	1.2751+03	1.2523+03
30	1.2305+03	1.2307+03	1.2876+03	1.2873+03	1.2751+03	1.2524+03

CONDENSING DATA REDUCTION

	209	211	213	215	217	219
	TC15C	TC16C	TC17C	TC18C	TC19C	TC20C
1	1.3021+03	1.3743+03	1.3670+03	1.3472+03	1.2913+03	1.2890+03
2	1.3021+03	1.3744+03	1.3670+03	1.3472+03	1.2911+03	1.2890+03
3	1.3021+03	1.3743+03	1.3672+03	1.3472+03	1.2911+03	1.2891+03
4	1.2206+03	1.2844+03	1.2787+03	1.2620+03	1.2138+03	1.2117+03
5	1.2207+03	1.2847+03	1.2789+03	1.2621+03	1.2139+03	1.2118+03
6	1.2206+03	1.2844+03	1.2787+03	1.2620+03	1.2138+03	1.2118+03
7	1.2015+03	1.2751+03	1.2673+03	1.2483+03	1.1930+03	1.1908+03
8	1.2016+03	1.2752+03	1.2673+03	1.2483+03	1.1931+03	1.1907+03
9	1.2014+03	1.2750+03	1.2672+03	1.2481+03	1.1929+03	1.1906+03
10	1.0938+03	1.1713+03	1.1624+03	1.1417+03	1.0819+03	1.0787+03
11	1.0934+03	1.1707+03	1.1619+03	1.1412+03	1.0814+03	1.0785+03
12	1.0930+03	1.1701+03	1.1613+03	1.1405+03	1.0810+03	1.0778+03
13	1.2825+03	1.3724+03	1.3633+03	1.3379+03	1.2674+03	1.2647+03
14	1.2825+03	1.3723+03	1.3633+03	1.3378+03	1.2674+03	1.2645+03
15	1.2824+03	1.3723+03	1.3633+03	1.3379+03	1.2674+03	1.2647+03
16	1.2185+03	1.3367+03	1.3249+03	1.2920+03	1.1994+03	1.1956+03
17	1.2178+03	1.3355+03	1.3238+03	1.2912+03	1.1992+03	1.1951+03
18	1.2177+03	1.3360+03	1.3243+03	1.2914+03	1.1992+03	1.1952+03
19	1.2470+03	1.3267+03	1.3185+03	1.2968+03	1.2354+03	1.2328+03
20	1.2468+03	1.3267+03	1.3184+03	1.2967+03	1.2350+03	1.2325+03
21	1.2465+03	1.3266+03	1.3182+03	1.2965+03	1.2349+03	1.2327+03
22	1.2774+03	1.3362+03	1.3306+03	1.3146+03	1.2701+03	1.2685+03
23	1.2774+03	1.3361+03	1.3305+03	1.3145+03	1.2700+03	1.2684+03
24	1.2774+03	1.3362+03	1.3305+03	1.3145+03	1.2698+03	1.2683+03
25	1.3042+03	1.3415+03	1.3383+03	1.3281+03	1.3004+03	1.2996+03
26	1.3042+03	1.3416+03	1.3383+03	1.3283+03	1.3007+03	1.2998+03
27	1.3042+03	1.3416+03	1.3383+03	1.3283+03	1.3006+03	1.2998+03
28	1.2493+03	1.2895+03	1.2858+03	1.2752+03	1.2456+03	1.2445+03
29	1.2493+03	1.2894+03	1.2857+03	1.2751+03	1.2456+03	1.2445+03
30	1.2494+03	1.2894+03	1.2856+03	1.2749+03	1.2455+03	1.2444+03

	221 TKICC	223 TKOC	226 TNAO	229 TNAI	230 DTNA	235 WNA
1	1.4052+03	1.4111+03	1.2972+03	1.2621+03	3.5110+01	4.5509+03
2	1.4052+03	1.4112+03	1.2971+03	1.2620+03	3.5138+01	4.5509+03
3	1.4051+03	1.4109+03	1.2970+03	1.2621+03	3.4924+01	4.5509+03
4	1.3074+03	1.3171+03	1.2173+03	1.1895+03	2.7898+01	4.5446+03
5	1.3078+03	1.3171+03	1.2174+03	1.1893+03	2.8069+01	4.5446+03
6	1.3070+03	1.3174+03	1.2174+03	1.1894+03	2.8026+01	4.5446+03
7	1.3099+03	1.3147+03	1.1978+03	1.1655+03	3.2292+01	4.5808+03
8	1.3103+03	1.3145+03	1.1977+03	1.1654+03	3.2306+01	4.5808+03
9	1.3101+03	1.3146+03	1.1976+03	1.1653+03	3.2334+01	4.5808+03
10	1.3197+03	1.2361+03	1.0898+03	1.0521+03	3.7642+01	4.6822+03
11	1.3194+03	1.2355+03	1.0890+03	1.0516+03	3.7358+01	4.6822+03
12	1.3195+03	1.2351+03	1.0887+03	1.0512+03	3.7511+01	4.6822+03
13	1.4139+03	1.4194+03	1.2755+03	1.2304+03	4.5082+01	4.4975+03
14	1.4142+03	1.4193+03	1.2756+03	1.2301+03	4.5496+01	4.4975+03
15	1.4140+03	1.4194+03	1.2756+03	1.2301+03	4.5438+01	4.4975+03
16	1.4150+03	1.4028+03	1.2105+03	1.1515+03	5.8963+01	4.5523+03
17	1.4150+03	1.4026+03	1.2103+03	1.1512+03	5.9119+01	4.5523+03
18	1.4147+03	1.4022+03	1.2099+03	1.1512+03	5.8618+01	4.5523+03
19	1.3612+03	1.3681+03	1.2415+03	1.2035+03	3.8005+01	4.5886+03
20	1.3611+03	1.3681+03	1.2413+03	1.2032+03	3.8118+01	4.5886+03
21	1.3610+03	1.3681+03	1.2412+03	1.2033+03	3.7890+01	4.5886+03
22	1.3584+03	1.3649+03	1.2738+03	1.2466+03	2.7158+01	4.5624+03
23	1.3582+03	1.3649+03	1.2737+03	1.2468+03	2.6859+01	4.5624+03
24	1.3582+03	1.3650+03	1.2738+03	1.2468+03	2.6988+01	4.5624+03
25	1.3568+03	1.3593+03	1.3020+03	1.2856+03	1.6392+01	4.6013+03
26	1.3571+03	1.3593+03	1.3022+03	1.2858+03	1.6364+01	4.6013+03
27	1.3570+03	1.3596+03	1.3024+03	1.2860+03	1.6408+01	4.6013+03
28	1.3034+03	1.3089+03	1.2478+03	1.2305+03	1.7299+01	4.5745+03
29	1.3038+03	1.3089+03	1.2478+03	1.2304+03	1.7384+01	4.5745+03
30	1.3036+03	1.3087+03	1.2477+03	1.2303+03	1.7312+01	4.5745+03

CONDENSING DATA REDUCTION

	237	238	240	243	246	247
	TNAM	CPNA	QNA	DTQL	QC	Q/AA
1	1.2796+03	3.0040-01	4.7998+04	1.2010+03	5.1115+04	1.7356+05
2	1.2795+03	3.0040-01	4.8037+04	1.2010+03	5.1153+04	1.7369+05
3	1.2796+03	3.0040-01	4.7744+04	1.2010+03	5.0860+04	1.7270+05
4	1.2034+03	3.0002-01	3.8037+04	1.1181+03	4.0814+04	1.3859+05
5	1.2034+03	3.0002-01	3.8271+04	1.1181+03	4.1047+04	1.3938+05
6	1.2034+03	3.0002-01	3.8213+04	1.1182+03	4.0990+04	1.3918+05
7	1.1816+03	3.0000-01	4.4377+04	1.0972+03	4.7071+04	1.5983+05
8	1.1815+03	3.0000-01	4.4396+04	1.0972+03	4.7089+04	1.5990+05
9	1.1814+03	3.0000-01	4.4435+04	1.0971+03	4.7128+04	1.6003+05
10	1.0709+03	3.0023-01	5.2916+04	9.8790+02	5.5190+04	1.8740+05
11	1.0703+03	3.0024-01	5.2518+04	9.8725+02	5.4789+04	1.8604+05
12	1.0700+03	3.0024-01	5.2733+04	9.8695+02	5.5003+04	1.8677+05
13	1.2530+03	3.0026-01	6.0881+04	1.1739+03	6.3885+04	2.1693+05
14	1.2529+03	3.0026-01	6.1440+04	1.1734+03	6.4441+04	2.1882+05
15	1.2528+03	3.0026-01	6.1362+04	1.1734+03	6.4364+04	2.1855+05
16	1.1810+03	3.0000-01	8.0526+04	1.1011+03	8.3235+04	2.8263+05
17	1.1807+03	3.0000-01	8.0738+04	1.1004+03	8.3445+04	2.8334+05
18	1.1806+03	3.0000-01	8.0054+04	1.1006+03	8.2761+04	2.8102+05
19	1.2225+03	3.0011-01	5.2337+04	1.1462+03	5.5227+04	1.8753+05
20	1.2222+03	3.0011-01	5.2492+04	1.1464+03	5.5383+04	1.8806+05
21	1.2222+03	3.0011-01	5.2177+04	1.1463+03	5.5068+04	1.8699+05
22	1.2602+03	3.0030-01	3.7209+04	1.1883+03	4.0272+04	1.3675+05
23	1.2603+03	3.0030-01	3.6799+04	1.1884+03	3.9863+04	1.3536+05
24	1.2603+03	3.0030-01	3.6975+04	1.1884+03	4.0039+04	1.3596+05
25	1.2938+03	3.0047-01	2.2663+04	1.2193+03	2.5856+04	8.7796+04
26	1.2940+03	3.0047-01	2.2624+04	1.2199+03	2.5820+04	8.7673+04
27	1.2942+03	3.0047-01	2.2685+04	1.2201+03	2.5881+04	8.7882+04
28	1.2391+03	3.0020-01	2.3755+04	1.1699+03	2.6743+04	9.0808+04
29	1.2391+03	3.0020-01	2.3873+04	1.1699+03	2.6860+04	9.1205+04
30	1.2390+03	3.0019-01	2.3774+04	1.1698+03	2.6761+04	9.0869+04

CONDENSING DATA REDUCTION

	251	306	317	319	324	326
	WK	TWI T	Q/A T	TWO T	HCON T	NUC T
1	6.1105+01	1.4037+03	1.8001+05	1.2892+03	-9.5482+05	-2.7793+00
2	6.1152+01	1.4035+03	1.7992+05	1.2891+03	-8.7929+06	-2.5595+01
3	6.0799+01	1.4033+03	1.7967+05	1.2891+03	5.4845+06	1.5964+01
4	4.7962+01	1.2989+03	1.3710+05	1.2099+03	2.1831+04	6.2470-02
5	4.8237+01	1.2989+03	1.3691+05	1.2100+03	2.0830+04	5.9609-02
6	4.8167+01	1.2992+03	1.3750+05	1.2099+03	2.3961+04	6.8563-02
7	5.5314+01	1.2923+03	1.5632+05	1.1905+03	1.2163+04	3.4806-02
8	5.5337+01	1.2924+03	1.5641+05	1.1905+03	1.1998+04	3.4336-02
9	5.5382+01	1.2922+03	1.5635+05	1.1903+03	1.1918+04	3.4105-02
10	6.4484+01	1.2194+03	2.0675+05	1.0818+03	2.7791+03	7.9368-03
11	6.4011+01	1.2188+03	2.0650+05	1.0814+03	2.7630+03	7.8906-03
12	6.4260+01	1.2181+03	2.0590+05	1.0810+03	2.7301+03	7.7964-03
13	7.6496+01	1.4118+03	2.2496+05	1.2684+03	-1.9640+05	-5.7284-01
14	7.7164+01	1.4119+03	2.2503+05	1.2684+03	-2.1069+05	-6.1452-01
15	7.7071+01	1.4116+03	2.2484+05	1.2683+03	-2.5064+05	-7.3104-01
16	9.9518+01	1.3861+03	2.8338+05	1.2034+03	1.5319+04	4.4604-02
17	9.9767+01	1.3832+03	2.7942+05	1.2030+03	1.3107+04	3.8164-02
18	9.8943+01	1.3847+03	2.8231+05	1.2026+03	1.4433+04	4.2020-02
19	6.5504+01	1.3566+03	1.8986+05	1.2343+03	1.7307+05	4.9971-01
20	6.5689+01	1.3568+03	1.9036+05	1.2342+03	2.5389+05	7.3303-01
21	6.5314+01	1.3565+03	1.9038+05	1.2340+03	2.0528+05	5.9267-01
22	4.7741+01	1.3555+03	1.3971+05	1.2659+03	8.2763+04	2.3894-01
23	4.7255+01	1.3554+03	1.3945+05	1.2659+03	8.2683+04	2.3870-01
24	4.7464+01	1.3556+03	1.3992+05	1.2659+03	9.9640+04	2.8765-01
25	3.0632+01	1.3543+03	9.4949+04	1.2936+03	4.8838+04	1.4097-01
26	3.0590+01	1.3544+03	9.4914+04	1.2937+03	4.4846+04	1.2946-01
27	3.0663+01	1.3544+03	9.5018+04	1.2937+03	4.5833+04	1.3231-01
28	3.1392+01	1.2998+03	9.3258+04	1.2395+03	3.1200+04	8.9244-02
29	3.1531+01	1.2999+03	9.3527+04	1.2394+03	2.9625+04	8.4744-02
30	3.1413+01	1.2998+03	9.3129+04	1.2396+03	3.0090+04	8.6070-02

CONDENSING DATA REDUCTION

	354	365	367	372	374	389
	TWI B	Q/A B	TWO B	HCON B	NUC B	TWI TC
1	1.4022+03	1.8849+05	1.2822+03	3.1201+04	9.0940-02	1.4071+03
2	1.4023+03	1.8885+05	1.2820+03	3.1680+04	9.2338-02	1.4070+03
3	1.4023+03	1.8878+05	1.2821+03	3.3094+04	9.6451-02	1.4068+03
4	1.3082+03	1.5627+05	1.2067+03	3.0162+04	8.6431-02	1.3019+03
5	1.3084+03	1.5658+05	1.2068+03	3.1399+04	8.9976-02	1.3019+03
6	1.3081+03	1.5616+05	1.2068+03	2.9321+04	8.4023-02	1.3021+03
7	1.3022+03	1.7999+05	1.1849+03	1.9144+04	5.4840-02	1.2953+03
8	1.3023+03	1.8007+05	1.1850+03	1.9367+04	5.5480-02	1.2954+03
9	1.3021+03	1.8007+05	1.1848+03	1.9002+04	5.4436-02	1.2952+03
10	1.2010+03	1.9068+05	1.0737+03	3.7014+03	1.0494-02	1.2222+03
11	1.2003+03	1.9015+05	1.0733+03	3.6769+03	1.0424-02	1.2216+03
12	1.1997+03	1.9006+05	1.0727+03	3.6499+03	1.0347-02	1.2208+03
13	1.4085+03	2.3859+05	1.2561+03	3.1039+04	9.0668-02	1.4154+03
14	1.4084+03	2.3863+05	1.2560+03	3.0888+04	9.0226-02	1.4154+03
15	1.4084+03	2.3840+05	1.2561+03	3.0523+04	8.9162-02	1.4152+03
16	1.3851+03	3.0951+05	1.1850+03	1.7687+04	5.1470-02	1.3897+03
17	1.3836+03	3.0749+05	1.1848+03	1.6324+04	4.7501-02	1.3867+03
18	1.3843+03	3.0869+05	1.1848+03	1.7309+04	5.0365-02	1.3883+03
19	1.3575+03	2.0420+05	1.2259+03	2.8797+04	8.3242-02	1.3599+03
20	1.3577+03	2.0512+05	1.2254+03	2.9768+04	8.6048-02	1.3601+03
21	1.3574+03	2.0452+05	1.2255+03	2.8542+04	8.2505-02	1.3598+03
22	1.3579+03	1.4777+05	1.2631+03	3.4250+04	9.8964-02	1.3586+03
23	1.3577+03	1.4767+05	1.2630+03	3.3391+04	9.6481-02	1.3585+03
24	1.3579+03	1.4825+05	1.2628+03	3.4941+04	1.0096-01	1.3588+03
25	1.3539+03	9.0689+04	1.2960+03	2.2637+04	6.5362-02	1.3574+03
26	1.3538+03	9.0193+04	1.2962+03	2.1661+04	6.2543-02	1.3575+03
27	1.3539+03	9.0399+04	1.2962+03	2.1008+04	6.0662-02	1.3575+03
28	1.3028+03	9.5168+04	1.2413+03	2.3906+04	6.8426-02	1.3027+03
29	1.3027+03	9.5014+04	1.2412+03	2.2710+04	6.5005-02	1.3028+03
30	1.3026+03	9.4986+04	1.2412+03	2.3130+04	6.6205-02	1.3027+03

CONDENSING DATA REDUCTION

	399	401	405	406	408	424
	Q/A TC	TWO TC	TKC-TW	HCONTC	NUC TC	TWI BC
1	1.7308+05	1.2972+03	-6.3651-01	-2.7192+05	-7.9218-01	1.4057+03
2	1.7300+05	1.2971+03	-4.6411-01	-3.7275+05	-1.0859+00	1.4058+03
3	1.7274+05	1.2971+03	-4.3932-01	-3.9321+05	-1.1455+00	1.4059+03
4	1.3088+05	1.2170+03	7.6431+00	1.7124+04	4.9039-02	1.3117+03
5	1.3069+05	1.2171+03	7.9736+00	1.6390+04	4.6938-02	1.3119+03
6	1.3128+05	1.2170+03	7.1566+00	1.8344+04	5.2529-02	1.3116+03
7	1.5050+05	1.1974+03	1.5649+01	9.6172+03	2.7547-02	1.3058+03
8	1.5059+05	1.1974+03	1.5816+01	9.5214+03	2.7274-02	1.3058+03
9	1.5053+05	1.1972+03	1.5920+01	9.4553+03	2.7084-02	1.3057+03
*10	2.0267+05	1.0874+03	7.8920+01	2.5680+03	7.3433-03	1.2046+03
*11	2.0242+05	1.0870+03	7.9158+01	2.5572+03	7.3120-03	1.2039+03
*12	2.0182+05	1.0866+03	7.9907+01	2.5257+03	7.2220-03	1.2033+03
13	2.1868+05	1.2762+03	-2.6643-01	-8.2077+05	-2.3968+00	1.4121+03
14	2.1875+05	1.2762+03	-1.1940-01	-1.8321+06	-5.3504+00	1.4121+03
15	2.1856+05	1.2761+03	4.6463-02	4.7039+06	1.3737+01	1.4120+03
*16	2.7840+05	1.2104+03	2.2642+01	1.2296+04	3.5878-02	1.3889+03
*17	2.7441+05	1.2100+03	2.5521+01	1.0752+04	3.1375-02	1.3874+03
*18	2.7732+05	1.2096+03	2.3636+01	1.1733+04	3.4233-02	1.3881+03
19	1.8373+05	1.2417+03	2.8918+00	6.3534+04	1.8360-01	1.3611+03
20	1.8424+05	1.2416+03	2.5800+00	7.1410+04	2.0635-01	1.3612+03
21	1.8426+05	1.2413+03	2.7027+00	6.8176+04	1.9700-01	1.3610+03
22	1.3279+05	1.2736+03	1.1771+00	1.1281+05	3.2583-01	1.3613+03
23	1.3252+05	1.2737+03	1.1250+00	1.1780+05	3.4023-01	1.3612+03
24	1.3300+05	1.2737+03	8.6440-01	1.5387+05	4.4440-01	1.3614+03
25	8.7299+04	1.3017+03	-2.8976-02	-3.0127+06	-8.6981+00	1.3572+03
26	8.7264+04	1.3018+03	1.3713-01	6.3636+05	1.8373+00	1.3572+03
27	8.7367+04	1.3018+03	1.0054-01	8.6898+05	2.5089+00	1.3572+03
28	8.6312+04	1.2469+03	1.9290+00	4.4744+04	1.2802-01	1.3062+03
29	8.6584+04	1.2469+03	2.1057+00	4.1118+04	1.1766-01	1.3061+03
30	8.6180+04	1.2470+03	2.0352+00	4.2345+04	1.2116-01	1.3060+03

*Subcooled liquid at test section outlet, therefore calculational
procedure not valid. Not plotted in Figure 20.

CONDENSING DATA REDUCTION

	434	436	439	440	442	450
	Q/A BC	TWO BC	TK-TWI	HCONBC	NUC BC	PSI HD
1	1.9435+05	1.2820+03	4.0742+00	4.7703+04	1.3910-01	1.6141+00
2	1.9471+05	1.2819+03	3.9947+00	4.8741+04	1.4213-01	1.6162+00
3	1.9464+05	1.2819+03	3.7279+00	5.2212+04	1.5224-01	1.5986+00
4	1.6303+05	1.2059+03	3.2801+00	4.9703+04	1.4247-01	1.6183+00
5	1.6335+05	1.2059+03	3.0956+00	5.2766+04	1.5125-01	1.6337+00
6	1.6292+05	1.2059+03	3.4425+00	4.7326+04	1.3565-01	1.6356+00
7	1.8713+05	1.1839+03	7.8470+00	2.3847+04	6.8337-02	2.1248+00
8	1.8721+05	1.1839+03	7.7369+00	2.4197+04	6.9341-02	2.1220+00
9	1.8722+05	1.1837+03	7.9217+00	2.3633+04	6.7726-02	2.1276+00
*10	1.9929+05	1.0716+03	5.0038+01	3.9828+03	1.1297-02	2.7440+00
*11	1.9876+05	1.0712+03	5.0205+01	3.9590+03	1.1228-02	2.7070+00
*12	1.9868+05	1.0706+03	5.0578+01	3.9282+03	1.1140-02	2.7276+00
13	2.4499+05	1.2557+03	6.0513+00	4.0485+04	1.1833-01	2.4283+00
14	2.4504+05	1.2556+03	6.1097+00	4.0107+04	1.1722-01	2.4674+00
15	2.4480+05	1.2557+03	6.1935+00	3.9525+04	1.1552-01	2.4630+00
*16	3.1712+05	1.1840+03	1.6564+01	1.9146+04	5.5761-02	4.0879+00
*17	3.1510+05	1.1838+03	1.7917+01	1.7587+04	5.1219-02	4.1082+00
*18	3.1631+05	1.1837+03	1.6877+01	1.8742+04	5.4578-02	4.0476+00
19	2.1088+05	1.2252+03	5.5031+00	3.8320+04	1.1081-01	2.2934+00
20	2.1181+05	1.2247+03	5.3115+00	3.9878+04	1.1531-01	2.3078+00
21	2.1120+05	1.2248+03	5.5715+00	3.7908+04	1.0961-01	2.2834+00
22	1.5374+05	1.2627+03	2.1601+00	7.1172+04	2.0569-01	1.2356+00
23	1.5364+05	1.2627+03	2.2536+00	6.8176+04	1.9703-01	1.2118+00
24	1.5422+05	1.2625+03	2.0795+00	7.4161+04	2.1433-01	1.2223+00
25	9.5995+04	1.2959+03	1.5169+00	6.3283+04	1.8275-01	5.1258-01
26	9.5493+04	1.2962+03	1.6745+00	5.7028+04	1.6469-01	5.1043-01
27	9.5701+04	1.2961+03	1.8159+00	5.2703+04	1.5220-01	5.1309-01
28	1.0124+05	1.2407+03	1.4751+00	6.8634+04	1.9648-01	7.0796-01
29	1.0109+05	1.2407+03	1.6810+00	6.0136+04	1.7216-01	7.1271-01
30	1.0106+05	1.2406+03	1.6001+00	6.3158+04	1.8080-01	7.0828-01

*Subcooled liquid at test section outlet, therefore calculational procedure not valid. Not plotted in Figure 20.

	451	452	453	610	611	613
	PI	PO	DPC	PIC	POC	DPCC
1	1.5300+01	1.5981+01	-6.8016-01	1.5585+01	1.6062+01	-4.7688-01
2	1.5304+01	1.5984+01	-6.8030-01	1.5589+01	1.6066+01	-4.7670-01
3	1.5297+01	1.5961+01	-6.6421-01	1.5579+01	1.6042+01	-4.6337-01
4	8.9237+00	9.6992+00	-7.7556-01	9.2044+00	9.7272+00	-5.2280-01
5	8.9414+00	9.6981+00	-7.5668-01	9.2246+00	9.7260+00	-5.0137-01
6	8.8993+00	9.7132+00	-8.1383-01	9.1838+00	9.7412+00	-5.5732-01
7	8.9569+00	9.5660+00	-6.0910-01	9.3341+00	9.5934+00	-2.5929-01
8	8.9791+00	9.5567+00	-5.7769-01	9.3557+00	9.5841+00	-2.2830-01
9	8.9680+00	9.5625+00	-5.9455-01	9.3456+00	9.5899+00	-2.4424-01
10	9.3563+00	6.0235+00	3.3329+00	9.8638+00	6.0276+00	3.8362+00
11	9.3517+00	6.0004+00	3.3512+00	9.8517+00	6.0045+00	3.8473+00
12	9.3494+00	5.9893+00	3.3600+00	9.8537+00	5.9933+00	3.8604+00
13	1.5846+01	1.6663+01	-8.1717-01	1.6289+01	1.6747+01	-4.5820-01
14	1.5863+01	1.6654+01	-7.9094-01	1.6315+01	1.6738+01	-4.2378-01
15	1.5852+01	1.6663+01	-8.1027-01	1.6303+01	1.6747+01	-4.4423-01
16	1.5601+01	1.5321+01	2.7975-01	1.6384+01	1.5396+01	9.8851-01
17	1.5597+01	1.5305+01	2.9177-01	1.6385+01	1.5380+01	1.0049+00
18	1.5580+01	1.5280+01	3.0031-01	1.6355+01	1.5354+01	1.0005+00
19	1.1977+01	1.2801+01	-8.2345-01	1.2389+01	1.2853+01	-4.6380-01
20	1.1966+01	1.2801+01	-8.3459-01	1.2381+01	1.2853+01	-4.7225-01
21	1.1961+01	1.2801+01	-8.4015-01	1.2370+01	1.2853+01	-4.8285-01
22	1.1991+01	1.2588+01	-5.9613-01	1.2200+01	1.2638+01	-4.3814-01
23	1.1983+01	1.2588+01	-6.0448-01	1.2188+01	1.2638+01	-4.5074-01
24	1.1983+01	1.2589+01	-6.0594-01	1.2190+01	1.2640+01	-4.5027-01
25	1.2019+01	1.2214+01	-1.9482-01	1.2100+01	1.2261+01	-1.6088-01
26	1.2039+01	1.2217+01	-1.7812-01	1.2119+01	1.2264+01	-1.4465-01
27	1.2033+01	1.2235+01	-2.0178-01	1.2114+01	1.2282+01	-1.6791-01
28	8.8838+00	9.2570+00	-3.7322-01	8.9986+00	9.2817+00	-2.8311-01
29	8.9038+00	9.2559+00	-3.5218-01	9.0192+00	9.2806+00	-2.6139-01
30	8.8927+00	9.2493+00	-3.5661-01	9.0075+00	9.2739+00	-2.6647-01

CONDENSING DATA REDUCTION

	700 X B	495 WKL B	701 X T	498 WKL T	504 NREF T	507 NREF B
1	2.5573-01	4.5479+01	8.0935-01	1.1650+01	1.4930+03	5.8374+03
2	2.5572-01	4.5514+01	8.0933-01	1.1660+01	1.4943+03	5.8421+03
3	2.5536-01	4.5273+01	8.0901-01	1.1612+01	1.4880+03	5.8105+03
4	2.6422-01	3.5289+01	8.1715-01	8.7698+00	1.0683+03	4.3126+03
5	2.6334-01	3.5535+01	8.1634-01	8.8593+00	1.0793+03	4.3427+03
6	2.6587-01	3.5361+01	8.1864-01	8.7356+00	1.0639+03	4.3216+03
7	2.5129-01	4.1414+01	8.0535-01	1.0767+01	1.3126+03	5.0570+03
8	2.5034-01	4.1484+01	8.0447-01	1.0820+01	1.3193+03	5.0653+03
9	2.5081-01	4.1492+01	8.0491-01	1.0805+01	1.3173+03	5.0664+03
10	2.4523-01	4.8670+01	8.0176-01	1.2783+01	1.5493+03	5.7485+03
11	2.4608-01	4.8259+01	8.0265-01	1.2633+01	1.5308+03	5.6982+03
12	2.4615-01	4.8443+01	8.0273-01	1.2677+01	1.5361+03	5.7191+03
13	2.5331-01	5.7118+01	8.0713-01	1.4754+01	1.8985+03	7.3606+03
14	2.5299-01	5.7642+01	8.0682-01	1.4906+01	1.9183+03	7.4280+03
15	2.5327-01	5.7551+01	8.0708-01	1.4869+01	1.9134+03	7.4165+03
16	2.3656-01	7.5976+01	7.9158-01	2.0741+01	2.6654+03	9.7321+03
17	2.3648-01	7.6174+01	7.9151-01	2.0801+01	2.6730+03	9.7568+03
18	2.3633-01	7.5560+01	7.9136-01	2.0643+01	2.6523+03	9.6766+03
19	2.5563-01	4.8759+01	8.0927-01	1.2493+01	1.5663+03	6.1238+03
20	2.5585-01	4.8882+01	8.0947-01	1.2515+01	1.5690+03	6.1393+03
21	2.5596-01	4.8596+01	8.0958-01	1.2437+01	1.5591+03	6.1032+03
22	2.5930-01	3.5361+01	8.1263-01	8.9453+00	1.1200+03	4.4348+03
23	2.5954-01	3.4990+01	8.1285-01	8.8437+00	1.1072+03	4.3882+03
24	2.5964-01	3.5140+01	8.1294-01	8.8786+00	1.1115+03	4.4070+03
25	2.5248-01	2.2898+01	8.0642-01	5.9297+00	7.4142+02	2.8652+03
26	2.5162-01	2.2893+01	8.0563-01	5.9456+00	7.4351+02	2.8647+03
27	2.5290-01	2.2908+01	8.0680-01	5.9240+00	7.4081+02	2.8670+03
28	2.6240-01	2.3155+01	8.1548-01	5.7924+00	7.0350+02	2.8173+03
29	2.6087-01	2.3305+01	8.1409-01	5.8617+00	7.1206+02	2.8357+03
30	2.6117-01	2.3209+01	8.1437-01	5.8314+00	7.0829+02	2.8238+03

CONDENSING DATA REDUCTION

	131 DATE	132 TIME	134 TC1	138 TC3	140 TC4	142 TC5
1	1.1450+03	4.4000+02	1.2981+03	1.3044+03	1.2945+03	1.2632+03
2	1.1450+03	4.4000+02	1.2979+03	1.3042+03	1.2943+03	1.2631+03
3	1.1450+03	4.4000+02	1.2977+03	1.3043+03	1.2944+03	1.2631+03
4	1.1450+03	6.3000+02	1.2572+03	1.2669+03	1.2574+03	1.2181+03
5	1.1450+03	6.3000+02	1.2571+03	1.2666+03	1.2571+03	1.2182+03
6	1.1450+03	6.3000+02	1.2572+03	1.2668+03	1.2573+03	1.2182+03
7	1.1450+03	7.3000+02	1.2497+03	1.2569+03	1.2478+03	1.2216+03
8	1.1450+03	7.3000+02	1.2497+03	1.2568+03	1.2476+03	1.2217+03
9	1.1450+03	7.3000+02	1.2496+03	1.2566+03	1.2476+03	1.2216+03
10	1.1450+03	9.0000+02	1.1964+03	1.2058+03	1.1972+03	1.1677+03
11	1.1450+03	9.0000+02	1.1963+03	1.2058+03	1.1972+03	1.1677+03
12	1.1450+03	9.0000+02	1.1964+03	1.2058+03	1.1972+03	1.1677+03
13	1.1450+03	1.3000+03	1.2036+03	1.2153+03	1.2065+03	1.1686+03
14	1.1450+03	1.3000+03	1.2035+03	1.2153+03	1.2066+03	1.1687+03
15	1.1450+03	1.3000+03	1.2037+03	1.2153+03	1.2065+03	1.1686+03
16	1.1450+03	1.4300+03	1.1497+03	1.1631+03	1.1549+03	1.1176+03
17	1.1450+03	1.4300+03	1.1498+03	1.1632+03	1.1550+03	1.1176+03
18	1.1450+03	1.4300+03	1.1497+03	1.1629+03	1.1546+03	1.1173+03
19	1.1450+03	1.7150+03	1.1416+03	1.1481+03	1.1403+03	1.1198+03
20	1.1450+03	1.7150+03	1.1419+03	1.1482+03	1.1403+03	1.1198+03
21	1.1450+03	1.7150+03	1.1418+03	1.1481+03	1.1403+03	1.1200+03
22	1.1450+03	1.9300+03	1.1829+03	1.1947+03	1.1865+03	1.1469+03
23	1.1450+03	1.9300+03	1.1831+03	1.1948+03	1.1866+03	1.1470+03
24	1.1450+03	1.9300+03	1.1832+03	1.1949+03	1.1866+03	1.1470+03
25	1.1450+03	2.1300+03	1.2316+03	1.2462+03	1.2373+03	1.1758+03
26	1.1450+03	2.1300+03	1.2315+03	1.2465+03	1.2376+03	1.1760+03
27	1.1450+03	2.1300+03	1.2325+03	1.2467+03	1.2379+03	1.1762+03
28	1.1550+03	8.3000+02	1.2885+03	1.3059+03	1.2963+03	1.1905+03
29	1.1550+03	8.3000+02	1.2888+03	1.3056+03	1.2961+03	1.1904+03
30	1.1550+03	8.3000+02	1.2884+03	1.3056+03	1.2961+03	1.1902+03

CONDENSING DATA REDUCTION

	144	146	148	150	152	154
	TC6	TC7	TC8	TC9	TC10	TC11
1	1.2644+03	1.2503+03	1.2569+03	1.2580+03	1.2582+03	1.2720+03
2	1.2644+03	1.2503+03	1.2570+03	1.2582+03	1.2583+03	1.2721+03
3	1.2643+03	1.2502+03	1.2568+03	1.2580+03	1.2582+03	1.2720+03
4	1.2192+03	1.2054+03	1.2098+03	1.2109+03	1.2112+03	1.2308+03
5	1.2192+03	1.2056+03	1.2099+03	1.2112+03	1.2113+03	1.2307+03
6	1.2192+03	1.2056+03	1.2100+03	1.2110+03	1.2113+03	1.2308+03
7	1.2229+03	1.2091+03	1.2174+03	1.2186+03	1.2184+03	1.2263+03
8	1.2228+03	1.2091+03	1.2172+03	1.2186+03	1.2183+03	1.2262+03
9	1.2227+03	1.2091+03	1.2174+03	1.2187+03	1.2183+03	1.2262+03
10	1.1687+03	1.1556+03	1.1628+03	1.1640+03	1.1638+03	1.1729+03
11	1.1687+03	1.1555+03	1.1627+03	1.1638+03	1.1637+03	1.1729+03
12	1.1686+03	1.1554+03	1.1626+03	1.1639+03	1.1637+03	1.1729+03
13	1.1695+03	1.1564+03	1.1615+03	1.1626+03	1.1626+03	1.1781+03
14	1.1697+03	1.1565+03	1.1615+03	1.1626+03	1.1625+03	1.1780+03
15	1.1695+03	1.1564+03	1.1617+03	1.1625+03	1.1626+03	1.1783+03
16	1.1185+03	1.1060+03	1.1117+03	1.1128+03	1.1127+03	1.1240+03
17	1.1185+03	1.1059+03	1.1115+03	1.1126+03	1.1125+03	1.1239+03
18	1.1185+03	1.1058+03	1.1116+03	1.1126+03	1.1128+03	1.1239+03
19	1.1210+03	1.1082+03	1.1178+03	1.1186+03	1.1189+03	1.1201+03
20	1.1209+03	1.1082+03	1.1176+03	1.1185+03	1.1189+03	1.1200+03
21	1.1210+03	1.1083+03	1.1177+03	1.1186+03	1.1189+03	1.1200+03
22	1.1480+03	1.1351+03	1.1402+03	1.1410+03	1.1414+03	1.1562+03
23	1.1480+03	1.1352+03	1.1401+03	1.1410+03	1.1413+03	1.1561+03
24	1.1479+03	1.1350+03	1.1400+03	1.1409+03	1.1412+03	1.1561+03
25	1.1763+03	1.1632+03	1.1626+03	1.1637+03	1.1640+03	1.1972+03
26	1.1765+03	1.1635+03	1.1627+03	1.1638+03	1.1641+03	1.1974+03
27	1.1767+03	1.1637+03	1.1630+03	1.1641+03	1.1644+03	1.1978+03
28	1.1906+03	1.1778+03	1.1627+03	1.1642+03	1.1644+03	1.2401+03
29	1.1904+03	1.1776+03	1.1626+03	1.1641+03	1.1643+03	1.2399+03
30	1.1903+03	1.1775+03	1.1630+03	1.1646+03	1.1647+03	1.2399+03

CONDENSING DATA REDUCTION

	156	158	160	162	164	166
	TC12	TC13	TC14	TC15	TC16	TC17
1	1.2939+03	1.2840+03	1.2670+03	1.2516+03	1.2812+03	1.2886+03
2	1.2939+03	1.2839+03	1.2668+03	1.2514+03	1.2811+03	1.2884+03
3	1.2939+03	1.2841+03	1.2669+03	1.2515+03	1.2812+03	1.2884+03
4	1.2518+03	1.2411+03	1.2223+03	1.2070+03	1.2411+03	1.2477+03
5	1.2518+03	1.2410+03	1.2223+03	1.2070+03	1.2412+03	1.2478+03
6	1.2518+03	1.2411+03	1.2224+03	1.2071+03	1.2411+03	1.2478+03
7	1.2474+03	1.2390+03	1.2246+03	1.2098+03	1.2356+03	1.2431+03
8	1.2474+03	1.2390+03	1.2246+03	1.2098+03	1.2356+03	1.2432+03
9	1.2475+03	1.2389+03	1.2245+03	1.2097+03	1.2355+03	1.2431+03
10	1.1929+03	1.1847+03	1.1704+03	1.1562+03	1.1833+03	1.1906+03
11	1.1929+03	1.1847+03	1.1705+03	1.1563+03	1.1834+03	1.1906+03
12	1.1929+03	1.1847+03	1.1705+03	1.1563+03	1.1835+03	1.1904+03
13	1.1983+03	1.1887+03	1.1723+03	1.1576+03	1.1902+03	1.1967+03
14	1.1982+03	1.1886+03	1.1722+03	1.1575+03	1.1901+03	1.1968+03
15	1.1984+03	1.1889+03	1.1722+03	1.1575+03	1.1902+03	1.1967+03
16	1.1430+03	1.1348+03	1.1206+03	1.1066+03	1.1376+03	1.1442+03
17	1.1429+03	1.1348+03	1.1207+03	1.1067+03	1.1376+03	1.1442+03
18	1.1428+03	1.1347+03	1.1205+03	1.1065+03	1.1375+03	1.1441+03
19	1.1388+03	1.1326+03	1.1218+03	1.1085+03	1.1292+03	1.1367+03
20	1.1389+03	1.1328+03	1.1220+03	1.1087+03	1.1292+03	1.1368+03
21	1.1388+03	1.1327+03	1.1219+03	1.1086+03	1.1294+03	1.1369+03
22	1.1758+03	1.1666+03	1.1504+03	1.1361+03	1.1693+03	1.1756+03
23	1.1757+03	1.1665+03	1.1504+03	1.1361+03	1.1693+03	1.1757+03
24	1.1757+03	1.1665+03	1.1505+03	1.1360+03	1.1694+03	1.1759+03
25	1.2176+03	1.2042+03	1.1811+03	1.1654+03	1.2134+03	1.2183+03
26	1.2178+03	1.2045+03	1.1815+03	1.1658+03	1.2138+03	1.2187+03
27	1.2182+03	1.2048+03	1.1815+03	1.1659+03	1.2137+03	1.2190+03
28	1.2607+03	1.2389+03	1.2003+03	1.1823+03	1.2577+03	1.2601+03
29	1.2604+03	1.2387+03	1.2001+03	1.1821+03	1.2576+03	1.2600+03
30	1.2603+03	1.2385+03	1.2004+03	1.1821+03	1.2576+03	1.2599+03

CONDENSING DATA REDUCTION

	168	170	172	174	176	181
	TC18	TC19	TC20	TKI	TKO	TC1C
1	1.2844+03	1.2659+03	1.2638+03	1.2981+03	1.2995+03	1.2981+03
2	1.2842+03	1.2659+03	1.2637+03	1.2979+03	1.2993+03	1.2979+03
3	1.2842+03	1.2658+03	1.2637+03	1.2977+03	1.2993+03	1.2977+03
4	1.2421+03	1.2204+03	1.2182+03	1.2572+03	1.2621+03	1.2572+03
5	1.2422+03	1.2206+03	1.2184+03	1.2571+03	1.2619+03	1.2571+03
6	1.2421+03	1.2206+03	1.2183+03	1.2572+03	1.2620+03	1.2572+03
7	1.2398+03	1.2246+03	1.2226+03	1.2497+03	1.2524+03	1.2497+03
8	1.2398+03	1.2246+03	1.2225+03	1.2497+03	1.2522+03	1.2497+03
9	1.2398+03	1.2247+03	1.2226+03	1.2496+03	1.2521+03	1.2496+03
10	1.1867+03	1.1705+03	1.1686+03	1.1964+03	1.2015+03	1.1964+03
11	1.1867+03	1.1706+03	1.1686+03	1.1963+03	1.2015+03	1.1963+03
12	1.1865+03	1.1703+03	1.1685+03	1.1964+03	1.2015+03	1.1964+03
13	1.1913+03	1.1712+03	1.1692+03	1.2036+03	1.2109+03	1.2036+03
14	1.1915+03	1.1714+03	1.1694+03	1.2035+03	1.2109+03	1.2035+03
15	1.1912+03	1.1711+03	1.1693+03	1.2037+03	1.2109+03	1.2037+03
16	1.1390+03	1.1206+03	1.1187+03	1.1497+03	1.1590+03	1.1497+03
17	1.1389+03	1.1206+03	1.1186+03	1.1498+03	1.1591+03	1.1498+03
18	1.1389+03	1.1204+03	1.1184+03	1.1497+03	1.1588+03	1.1497+03
19	1.1342+03	1.1231+03	1.1215+03	1.1416+03	1.1442+03	1.1416+03
20	1.1342+03	1.1230+03	1.1215+03	1.1419+03	1.1442+03	1.1419+03
21	1.1344+03	1.1233+03	1.1217+03	1.1418+03	1.1442+03	1.1418+03
22	1.1701+03	1.1499+03	1.1480+03	1.1829+03	1.1906+03	1.1829+03
23	1.1702+03	1.1500+03	1.1481+03	1.1831+03	1.1907+03	1.1831+03
24	1.1703+03	1.1499+03	1.1481+03	1.1832+03	1.1908+03	1.1832+03
25	1.2092+03	1.1780+03	1.1757+03	1.2316+03	1.2418+03	1.2316+03
26	1.2095+03	1.1783+03	1.1759+03	1.2315+03	1.2421+03	1.2315+03
27	1.2097+03	1.1785+03	1.1762+03	1.2325+03	1.2423+03	1.2325+03
28	1.2435+03	1.1902+03	1.1868+03	1.2885+03	1.3011+03	1.2885+03
29	1.2435+03	1.1900+03	1.1866+03	1.2888+03	1.3009+03	1.2888+03
30	1.2435+03	1.1902+03	1.1868+03	1.2884+03	1.3009+03	1.2884+03

CONDENSING DATA REDUCTION

	185	187	189	191	193	195
	TC3C	TC4C	TC5C	TC6C	TC7C	TC8C
1	1.3005+03	1.2993+03	1.2664+03	1.2665+03	1.2666+03	1.2569+03
2	1.3003+03	1.2991+03	1.2663+03	1.2664+03	1.2666+03	1.2570+03
3	1.3004+03	1.2992+03	1.2663+03	1.2664+03	1.2665+03	1.2568+03
4	1.2629+03	1.2618+03	1.2212+03	1.2212+03	1.2212+03	1.2098+03
5	1.2626+03	1.2616+03	1.2214+03	1.2212+03	1.2214+03	1.2099+03
6	1.2629+03	1.2617+03	1.2213+03	1.2212+03	1.2214+03	1.2100+03
7	1.2530+03	1.2522+03	1.2248+03	1.2248+03	1.2249+03	1.2174+03
8	1.2528+03	1.2519+03	1.2248+03	1.2248+03	1.2249+03	1.2172+03
9	1.2526+03	1.2519+03	1.2247+03	1.2247+03	1.2249+03	1.2174+03
10	1.2018+03	1.2010+03	1.1707+03	1.1706+03	1.1708+03	1.1628+03
11	1.2019+03	1.2010+03	1.1707+03	1.1706+03	1.1707+03	1.1627+03
12	1.2019+03	1.2011+03	1.1707+03	1.1705+03	1.1706+03	1.1626+03
13	1.2113+03	1.2104+03	1.1716+03	1.1714+03	1.1716+03	1.1615+03
14	1.2113+03	1.2105+03	1.1717+03	1.1715+03	1.1716+03	1.1615+03
15	1.2113+03	1.2104+03	1.1716+03	1.1714+03	1.1716+03	1.1617+03
16	1.1591+03	1.1583+03	1.1205+03	1.1203+03	1.1206+03	1.1117+03
17	1.1592+03	1.1584+03	1.1205+03	1.1203+03	1.1205+03	1.1115+03
18	1.1589+03	1.1580+03	1.1202+03	1.1203+03	1.1204+03	1.1116+03
19	1.1441+03	1.1435+03	1.1227+03	1.1228+03	1.1228+03	1.1178+03
20	1.1442+03	1.1436+03	1.1227+03	1.1227+03	1.1228+03	1.1176+03
21	1.1442+03	1.1436+03	1.1228+03	1.1228+03	1.1230+03	1.1177+03
22	1.1908+03	1.1902+03	1.1499+03	1.1498+03	1.1501+03	1.1402+03
23	1.1909+03	1.1904+03	1.1499+03	1.1498+03	1.1501+03	1.1401+03
24	1.1910+03	1.1904+03	1.1500+03	1.1498+03	1.1499+03	1.1400+03
25	1.2422+03	1.2415+03	1.1788+03	1.1782+03	1.1785+03	1.1626+03
26	1.2426+03	1.2418+03	1.1790+03	1.1784+03	1.1788+03	1.1627+03
27	1.2427+03	1.2421+03	1.1792+03	1.1786+03	1.1790+03	1.1630+03
28	1.3020+03	1.3011+03	1.1936+03	1.1925+03	1.1932+03	1.1627+03
29	1.3017+03	1.3009+03	1.1935+03	1.1923+03	1.1931+03	1.1626+03
30	1.3017+03	1.3009+03	1.1932+03	1.1922+03	1.1929+03	1.1630+03

CONDENSING DATA REDUCTION

	197	199	201	203	205	207
	TC9C	TC10C	TC11C	TC12C	TC13C	TC14C
1	1.2574+03	1.2576+03	1.2894+03	1.2895+03	1.2821+03	1.2686+03
2	1.2575+03	1.2578+03	1.2895+03	1.2895+03	1.2820+03	1.2684+03
3	1.2574+03	1.2577+03	1.2895+03	1.2895+03	1.2822+03	1.2686+03
4	1.2103+03	1.2106+03	1.2475+03	1.2475+03	1.2391+03	1.2236+03
5	1.2105+03	1.2107+03	1.2475+03	1.2474+03	1.2390+03	1.2236+03
6	1.2104+03	1.2107+03	1.2475+03	1.2475+03	1.2391+03	1.2238+03
7	1.2180+03	1.2178+03	1.2429+03	1.2431+03	1.2370+03	1.2259+03
8	1.2179+03	1.2177+03	1.2429+03	1.2431+03	1.2370+03	1.2259+03
9	1.2181+03	1.2177+03	1.2428+03	1.2432+03	1.2369+03	1.2258+03
10	1.1633+03	1.1631+03	1.1886+03	1.1888+03	1.1825+03	1.1714+03
11	1.1632+03	1.1630+03	1.1885+03	1.1887+03	1.1825+03	1.1715+03
12	1.1632+03	1.1631+03	1.1885+03	1.1888+03	1.1826+03	1.1715+03
13	1.1619+03	1.1619+03	1.1939+03	1.1941+03	1.1866+03	1.1733+03
14	1.1619+03	1.1618+03	1.1938+03	1.1941+03	1.1865+03	1.1732+03
15	1.1618+03	1.1620+03	1.1941+03	1.1942+03	1.1868+03	1.1732+03
16	1.1121+03	1.1120+03	1.1388+03	1.1389+03	1.1326+03	1.1212+03
17	1.1119+03	1.1118+03	1.1387+03	1.1388+03	1.1326+03	1.1213+03
18	1.1119+03	1.1120+03	1.1386+03	1.1388+03	1.1324+03	1.1211+03
19	1.1179+03	1.1182+03	1.1348+03	1.1347+03	1.1304+03	1.1224+03
20	1.1178+03	1.1182+03	1.1347+03	1.1348+03	1.1305+03	1.1226+03
21	1.1179+03	1.1182+03	1.1347+03	1.1347+03	1.1304+03	1.1226+03
22	1.1403+03	1.1407+03	1.1716+03	1.1717+03	1.1645+03	1.1513+03
23	1.1403+03	1.1406+03	1.1715+03	1.1715+03	1.1643+03	1.1512+03
24	1.1402+03	1.1406+03	1.1715+03	1.1716+03	1.1643+03	1.1513+03
25	1.1630+03	1.1634+03	1.2133+03	1.2133+03	1.2021+03	1.1822+03
26	1.1631+03	1.1634+03	1.2136+03	1.2135+03	1.2025+03	1.1826+03
27	1.1634+03	1.1638+03	1.2140+03	1.2139+03	1.2028+03	1.1826+03
28	1.1635+03	1.1638+03	1.2570+03	1.2564+03	1.2369+03	1.2015+03
29	1.1634+03	1.1636+03	1.2568+03	1.2561+03	1.2367+03	1.2013+03
30	1.1639+03	1.1640+03	1.2568+03	1.2560+03	1.2365+03	1.2016+03

CONDENSING DATA REDUCTION

	209 TC15C	211 TC16C	213 TC17C	215 TC18C	217 TC19C	219 TC20C
1	1.2669+03	1.2895+03	1.2876+03	1.2817+03	1.2657+03	1.2652+03
2	1.2667+03	1.2893+03	1.2874+03	1.2816+03	1.2656+03	1.2652+03
3	1.2668+03	1.2894+03	1.2874+03	1.2816+03	1.2656+03	1.2651+03
4	1.2216+03	1.2491+03	1.2466+03	1.2395+03	1.2198+03	1.2190+03
5	1.2215+03	1.2492+03	1.2467+03	1.2396+03	1.2201+03	1.2193+03
6	1.2216+03	1.2492+03	1.2467+03	1.2395+03	1.2200+03	1.2192+03
7	1.2244+03	1.2436+03	1.2420+03	1.2372+03	1.2240+03	1.2235+03
8	1.2244+03	1.2437+03	1.2420+03	1.2372+03	1.2240+03	1.2235+03
9	1.2243+03	1.2435+03	1.2420+03	1.2372+03	1.2241+03	1.2235+03
10	1.1698+03	1.1911+03	1.1893+03	1.1841+03	1.1696+03	1.1689+03
11	1.1700+03	1.1912+03	1.1894+03	1.1841+03	1.1697+03	1.1689+03
12	1.1700+03	1.1912+03	1.1892+03	1.1840+03	1.1695+03	1.1687+03
13	1.1713+03	1.1980+03	1.1955+03	1.1888+03	1.1703+03	1.1695+03
14	1.1712+03	1.1979+03	1.1955+03	1.1890+03	1.1705+03	1.1696+03
15	1.1712+03	1.1980+03	1.1955+03	1.1887+03	1.1702+03	1.1696+03
16	1.1195+03	1.1451+03	1.1428+03	1.1365+03	1.1194+03	1.1184+03
17	1.1195+03	1.1451+03	1.1427+03	1.1364+03	1.1193+03	1.1183+03
18	1.1193+03	1.1450+03	1.1427+03	1.1364+03	1.1192+03	1.1180+03
19	1.1214+03	1.1366+03	1.1353+03	1.1318+03	1.1219+03	1.1212+03
20	1.1216+03	1.1367+03	1.1353+03	1.1317+03	1.1218+03	1.1212+03
21	1.1215+03	1.1369+03	1.1355+03	1.1319+03	1.1221+03	1.1214+03
22	1.1495+03	1.1770+03	1.1743+03	1.1676+03	1.1489+03	1.1480+03
23	1.1495+03	1.1770+03	1.1744+03	1.1677+03	1.1490+03	1.1481+03
24	1.1494+03	1.1771+03	1.1745+03	1.1678+03	1.1489+03	1.1481+03
25	1.1793+03	1.2213+03	1.2171+03	1.2067+03	1.1772+03	1.1760+03
26	1.1797+03	1.2217+03	1.2175+03	1.2069+03	1.1775+03	1.1763+03
27	1.1797+03	1.2216+03	1.2178+03	1.2071+03	1.1776+03	1.1765+03
28	1.1964+03	1.2659+03	1.2590+03	1.2409+03	1.1894+03	1.1873+03
29	1.1962+03	1.2658+03	1.2590+03	1.2409+03	1.1892+03	1.1871+03
30	1.1963+03	1.2658+03	1.2588+03	1.2410+03	1.1895+03	1.1873+03

CONDENSING DATA REDUCTION

	221 TKICC	223 TKOC	226 TNAO	229 TNAI	230 DTNA	235 WNA
1	1.2988+03	1.2999+03	1.2665+03	1.2573+03	9.1796+00	4.5242+03
2	1.2986+03	1.2997+03	1.2664+03	1.2574+03	8.9941+00	4.5242+03
3	1.2984+03	1.2998+03	1.2664+03	1.2573+03	9.0935+00	4.5242+03
4	1.2586+03	1.2624+03	1.2212+03	1.2102+03	1.0956+01	4.4773+03
5	1.2585+03	1.2621+03	1.2213+03	1.2104+03	1.0942+01	4.4773+03
6	1.2586+03	1.2623+03	1.2213+03	1.2103+03	1.0942+01	4.4773+03
7	1.2504+03	1.2526+03	1.2248+03	1.2177+03	7.1255+00	4.5367+03
8	1.2504+03	1.2524+03	1.2248+03	1.2176+03	7.1968+00	4.5367+03
9	1.2503+03	1.2523+03	1.2248+03	1.2177+03	7.0399+00	4.5367+03
10	1.1977+03	1.2014+03	1.1707+03	1.1631+03	7.5911+00	4.5392+03
11	1.1977+03	1.2014+03	1.1706+03	1.1630+03	7.6762+00	4.5392+03
12	1.1978+03	1.2015+03	1.1706+03	1.1630+03	7.6331+00	4.5392+03
13	1.2056+03	1.2108+03	1.1715+03	1.1618+03	9.7615+00	4.5009+03
14	1.2055+03	1.2109+03	1.1716+03	1.1618+03	9.8758+00	4.5009+03
15	1.2056+03	1.2108+03	1.1715+03	1.1618+03	9.6758+00	4.5009+03
16	1.1525+03	1.1587+03	1.1205+03	1.1119+03	8.5744+00	4.5301+03
17	1.1526+03	1.1588+03	1.1204+03	1.1118+03	8.6728+00	4.5301+03
18	1.1524+03	1.1585+03	1.1203+03	1.1118+03	8.4605+00	4.5301+03
19	1.1427+03	1.1438+03	1.1228+03	1.1180+03	4.7839+00	4.5964+03
20	1.1431+03	1.1439+03	1.1227+03	1.1179+03	4.8403+00	4.5964+03
21	1.1430+03	1.1439+03	1.1229+03	1.1179+03	4.9541+00	4.5964+03
22	1.1854+03	1.1905+03	1.1499+03	1.1404+03	9.5220+00	4.6431+03
23	1.1856+03	1.1906+03	1.1500+03	1.1403+03	9.6353+00	4.6431+03
24	1.1857+03	1.1907+03	1.1499+03	1.1402+03	9.6488+00	4.6431+03
25	1.2352+03	1.2419+03	1.1785+03	1.1630+03	1.5539+01	4.6042+03
26	1.2352+03	1.2422+03	1.1787+03	1.1631+03	1.5639+01	4.6042+03
27	1.2360+03	1.2424+03	1.1789+03	1.1634+03	1.5512+01	4.6042+03
28	1.2955+03	1.3015+03	1.1931+03	1.1633+03	2.9747+01	4.5284+03
29	1.2957+03	1.3013+03	1.1930+03	1.1632+03	2.9747+01	4.5284+03
30	1.2951+03	1.3013+03	1.1928+03	1.1636+03	2.9147+01	4.5284+03

CONDENSING DATA REDUCTION

	237	238	240	243	246	247
	TNAM	CPNA	QNA	DTQL	QC	Q/AA
1	1.2619+03	3.0031-01	1.2472+04	1.1976+03	1.5574+04	5.2883+04
2	1.2619+03	3.0031-01	1.2220+04	1.1976+03	1.5322+04	5.2028+04
3	1.2619+03	3.0031-01	1.2355+04	1.1980+03	1.5459+04	5.2492+04
4	1.2157+03	3.0008-01	1.4720+04	1.1519+03	1.7633+04	5.9874+04
5	1.2158+03	3.0008-01	1.4701+04	1.1516+03	1.7613+04	5.9808+04
6	1.2158+03	3.0008-01	1.4701+04	1.1515+03	1.7613+04	5.9807+04
7	1.2213+03	3.0011-01	9.7013+03	1.1574+03	1.2637+04	4.2911+04
8	1.2212+03	3.0011-01	9.7983+03	1.1574+03	1.2734+04	4.3240+04
9	1.2212+03	3.0011-01	9.5848+03	1.1574+03	1.2521+04	4.2515+04
10	1.1669+03	3.0000-01	1.0337+04	1.1004+03	1.3043+04	4.4290+04
11	1.1668+03	3.0000-01	1.0453+04	1.1007+03	1.3161+04	4.4688+04
12	1.1668+03	3.0000-01	1.0395+04	1.1007+03	1.3102+04	4.4489+04
13	1.1667+03	3.0000-01	1.3181+04	1.0943+03	1.5863+04	5.3864+04
14	1.1667+03	3.0000-01	1.3335+04	1.0944+03	1.6017+04	5.4389+04
15	1.1667+03	3.0000-01	1.3065+04	1.0943+03	1.5747+04	5.3471+04
16	1.1162+03	3.0000-01	1.1653+04	1.0452+03	1.4143+04	4.8025+04
17	1.1161+03	3.0000-01	1.1787+04	1.0451+03	1.4277+04	4.8478+04
18	1.1161+03	3.0000-01	1.1498+04	1.0451+03	1.3988+04	4.7498+04
19	1.1204+03	3.0000-01	6.5966+03	1.0530+03	9.1171+03	3.0958+04
20	1.1203+03	3.0000-01	6.6745+03	1.0529+03	9.1947+03	3.1222+04
21	1.1204+03	3.0000-01	6.8313+03	1.0530+03	9.3519+03	3.1755+04
22	1.1452+03	3.0000-01	1.3263+04	1.0827+03	1.5900+04	5.3989+04
23	1.1451+03	3.0000-01	1.3421+04	1.0826+03	1.6057+04	5.4524+04
24	1.1451+03	3.0000-01	1.3440+04	1.0821+03	1.6074+04	5.4581+04
25	1.1707+03	3.0000-01	2.1463+04	1.1087+03	2.4202+04	8.2180+04
26	1.1709+03	3.0000-01	2.1602+04	1.1089+03	2.4342+04	8.2655+04
27	1.1712+03	3.0000-01	2.1426+04	1.1091+03	2.4167+04	8.2061+04
28	1.1782+03	3.0000-01	4.0412+04	1.1117+03	4.3163+04	1.4656+05
29	1.1781+03	3.0000-01	4.0411+04	1.1111+03	4.3160+04	1.4655+05
30	1.1782+03	3.0000-01	3.9597+04	1.1112+03	4.2346+04	1.4379+05

CONDENSING DATA REDUCTION

	251	306	317	319	324	326
	WK	TWI T	Q/A T	TWO T	HCON T	NUC T
1	1.8260+01	1.2957+03	5.8742+04	1.2578+03	2.1640+04	6.1851-02
2	1.7964+01	1.2958+03	5.9226+04	1.2576+03	2.5107+04	7.1758-02
3	1.8124+01	1.2958+03	5.9004+04	1.2577+03	2.6164+04	7.4777-02
4	2.0545+01	1.2552+03	6.5063+04	1.2128+03	2.1360+04	6.0622-02
5	2.0521+01	1.2552+03	6.5002+04	1.2128+03	2.1429+04	6.0816-02
6	2.0522+01	1.2551+03	6.4742+04	1.2129+03	2.0545+04	5.8309-02
7	1.4703+01	1.2479+03	4.8739+04	1.2161+03	2.0481+04	5.8047-02
8	1.4815+01	1.2478+03	4.8588+04	1.2161+03	1.9741+04	5.5948-02
9	1.4567+01	1.2479+03	4.8916+04	1.2160+03	2.1633+04	6.1309-02
10	1.5050+01	1.1938+03	4.8001+04	1.1621+03	1.3001+04	3.6511-02
11	1.5185+01	1.1937+03	4.7506+04	1.1623+03	1.2439+04	3.4932-02
12	1.5117+01	1.1937+03	4.7662+04	1.1623+03	1.2607+04	3.5405-02
13	1.8328+01	1.2006+03	5.6378+04	1.1634+03	1.2096+04	3.4008-02
14	1.8507+01	1.2005+03	5.6365+04	1.1633+03	1.2157+04	3.4180-02
15	1.8195+01	1.2008+03	5.6899+04	1.1633+03	1.2853+04	3.6138-02
16	1.6217+01	1.1444+03	4.7882+04	1.1124+03	6.4400+03	1.8003-02
17	1.6370+01	1.1442+03	4.7491+04	1.1125+03	6.2182+03	1.7383-02
18	1.6039+01	1.1442+03	4.7825+04	1.1123+03	6.3395+03	1.7722-02
19	1.0435+01	1.1380+03	3.5067+04	1.1145+03	8.3700+03	2.3376-02
20	1.0525+01	1.1379+03	3.4654+04	1.1147+03	7.7126+03	2.1540-02
21	1.0704+01	1.1378+03	3.4640+04	1.1147+03	7.7341+03	2.1600-02
22	1.8315+01	1.1781+03	5.4795+04	1.1418+03	8.4482+03	2.3695-02
23	1.8497+01	1.1780+03	5.4620+04	1.1418+03	7.9890+03	2.2407-02
24	1.8516+01	1.1780+03	5.4662+04	1.1418+03	7.9359+03	2.2258-02
25	2.8099+01	1.2243+03	8.1616+04	1.1706+03	8.4826+03	2.3971-02
26	2.8262+01	1.2244+03	8.1239+04	1.1710+03	8.5990+03	2.4300-02
27	2.8062+01	1.2250+03	8.2046+04	1.1710+03	8.4677+03	2.3932-02
28	5.0600+01	1.2777+03	1.4046+05	1.1860+03	1.0324+04	2.9470-02
29	5.0596+01	1.2774+03	1.4037+05	1.1858+03	1.0023+04	2.8613-02
30	4.9640+01	1.2772+03	1.3980+05	1.1860+03	1.0022+04	2.8608-02

CONDENSING DATA REDUCTION

	354	365	367	372	374	389
	TWI B	Q/A B	TWO B	HCON B	NUC B	TWI TC
1	1.2953+03	4.9432+04	1.2634+03	1.2876+04	3.6808-02	1.2985+03
2	1.2951+03	4.9068+04	1.2634+03	1.2591+04	3.5992-02	1.2986+03
3	1.2952+03	4.9379+04	1.2633+03	1.3051+04	3.7305-02	1.2986+03
4	1.2569+03	6.0758+04	1.2173+03	1.4669+04	4.1654-02	1.2579+03
5	1.2569+03	6.0421+04	1.2176+03	1.5562+04	4.4188-02	1.2578+03
6	1.2569+03	6.0556+04	1.2175+03	1.4979+04	4.2533-02	1.2578+03
7	1.2478+03	3.8799+04	1.2226+03	9.8768+03	2.8000-02	1.2505+03
8	1.2479+03	3.8943+04	1.2225+03	1.0453+04	2.9634-02	1.2504+03
9	1.2477+03	3.8446+04	1.2226+03	1.0000+04	2.8349-02	1.2505+03
10	1.1960+03	4.1972+04	1.1684+03	9.7821+03	2.7480-02	1.1962+03
11	1.1961+03	4.2108+04	1.1684+03	9.9771+03	2.8027-02	1.1960+03
12	1.1961+03	4.2302+04	1.1682+03	9.8381+03	2.7637-02	1.1961+03
13	1.2050+03	5.5631+04	1.1684+03	1.3211+04	3.7171-02	1.2030+03
14	1.2050+03	5.5264+04	1.1686+03	1.2941+04	3.6412-02	1.2029+03
15	1.2050+03	5.5539+04	1.1684+03	1.2998+04	3.6572-02	1.2033+03
16	1.1515+03	5.0200+04	1.1180+03	9.1780+03	2.5670-02	1.1465+03
17	1.1515+03	5.0282+04	1.1179+03	9.0903+03	2.5425-02	1.1464+03
18	1.1515+03	5.0547+04	1.1177+03	9.5291+03	2.6652-02	1.1464+03
19	1.1390+03	2.5802+04	1.1217+03	5.5717+03	1.5563-02	1.1401+03
20	1.1391+03	2.6074+04	1.1217+03	5.6081+03	1.5665-02	1.1400+03
21	1.1392+03	2.5885+04	1.1219+03	5.7290+03	1.6002-02	1.1400+03
22	1.1841+03	5.5924+04	1.1471+03	1.1713+04	3.2865-02	1.1805+03
23	1.1841+03	5.5792+04	1.1472+03	1.1393+04	3.1969-02	1.1803+03
24	1.1843+03	5.6172+04	1.1472+03	1.1843+04	3.3231-02	1.1803+03
25	1.2344+03	9.2807+04	1.1734+03	1.8111+04	5.1232-02	1.2268+03
26	1.2348+03	9.3039+04	1.1737+03	1.8722+04	5.2963-02	1.2270+03
27	1.2348+03	9.2800+04	1.1739+03	1.7594+04	4.9773-02	1.2275+03
28	1.2912+03	1.6743+05	1.1820+03	2.3595+04	6.7439-02	1.2806+03
29	1.2912+03	1.6772+05	1.1818+03	2.4056+04	6.8754-02	1.2803+03
30	1.2910+03	1.6703+05	1.1820+03	2.3532+04	6.7255-02	1.2801+03

CONDENSING DATA REDUCTION

	399	401	405	406	408	424
	Q/A TC	TWO TC	TKC-TW	HCONTC	NUC TC	TWI BC
1	5.1279+04	1.2654+03	5.5766-01	9.1953+04	2.6285-01	1.2986+03
2	5.1770+04	1.2652+03	1.8216-01	2.8420+05	8.1237-01	1.2983+03
3	5.1545+04	1.2654+03	9.0881-02	5.6716+05	1.6211+00	1.2985+03
4	5.8242+04	1.2200+03	1.5312+00	3.8037+04	1.0797-01	1.2602+03
5	5.8182+04	1.2199+03	1.5163+00	3.8372+04	1.0892-01	1.2602+03
6	5.7918+04	1.2201+03	1.6338+00	3.5451+04	1.0063-01	1.2602+03
7	4.1747+04	1.2233+03	3.9461-01	1.0579+05	2.9986-01	1.2511+03
8	4.1595+04	1.2233+03	4.8563-01	8.5652+04	2.4278-01	1.2512+03
9	4.1925+04	1.2232+03	2.6538-01	1.5798+05	4.4778-01	1.2510+03
10	4.1702+04	1.1687+03	2.3707+00	1.7590+04	4.9404-02	1.1993+03
11	4.1201+04	1.1689+03	2.5209+00	1.6344+04	4.5904-02	1.1994+03
12	4.1357+04	1.1688+03	2.4711+00	1.6737+04	4.7006-02	1.1994+03
13	5.0127+04	1.1700+03	3.7497+00	1.3368+04	3.7597-02	1.2084+03
14	5.0114+04	1.1699+03	3.7597+00	1.3329+04	3.7487-02	1.2083+03
15	5.0654+04	1.1699+03	3.4884+00	1.4521+04	4.0837-02	1.2083+03
16	4.2214+04	1.1184+03	7.3512+00	5.7425+03	1.6056-02	1.1548+03
17	4.1819+04	1.1185+03	7.5984+00	5.5037+03	1.5389-02	1.1548+03
18	4.2157+04	1.1183+03	7.4094+00	5.6897+03	1.5909-02	1.1548+03
19	2.9274+04	1.1205+03	2.8947+00	1.0113+04	2.8246-02	1.1422+03
20	2.8854+04	1.1208+03	3.2140+00	8.9776+03	2.5075-02	1.1423+03
21	2.8841+04	1.1207+03	3.2358+00	8.9130+03	2.4895-02	1.1424+03
22	4.8808+04	1.1481+03	6.0561+00	8.0593+03	2.2608-02	1.1875+03
23	4.8632+04	1.1481+03	6.4446+00	7.5462+03	2.1169-02	1.1875+03
24	4.8675+04	1.1481+03	6.4979+00	7.4909+03	2.1014-02	1.1877+03
25	7.5470+04	1.1772+03	9.8994+00	7.6237+03	2.1555-02	1.2378+03
26	7.5086+04	1.1777+03	9.7632+00	7.6907+03	2.1745-02	1.2382+03
27	7.5898+04	1.1777+03	9.9297+00	7.6436+03	2.1614-02	1.2382+03
28	1.3458+05	1.1928+03	1.6234+01	8.2902+03	2.3689-02	1.2947+03
29	1.3450+05	1.1926+03	1.6619+01	8.0932+03	2.3126-02	1.2947+03
30	1.3392+05	1.1928+03	1.6368+01	8.1815+03	2.3376-02	1.2945+03

CONDENSING DATA REDUCTION

	434	436	439	440	442	450
	Q/A BC	TWO BC	TK-TWI	HCONBC	NUC BC	PSI HD
1	5.5035+04	1.2631+03	1.0648+00	5.1686+04	1.4776-01	2.4546-01
2	5.4670+04	1.2631+03	1.1177+00	4.8912+04	1.3983-01	2.3791-01
3	5.4983+04	1.2630+03	1.0072+00	5.4591+04	1.5606-01	2.4237-01
4	6.7031+04	1.2165+03	1.3303+00	5.0386+04	1.4309-01	3.8687-01
5	6.6689+04	1.2168+03	1.0703+00	6.2311+04	1.7694-01	3.8609-01
6	6.6826+04	1.2167+03	1.2302+00	5.4322+04	1.5426-01	3.8592-01
7	4.4922+04	1.2218+03	9.7673-01	4.5992+04	1.3039-01	2.0746-01
8	4.5066+04	1.2218+03	7.7530-01	5.8128+04	1.6479-01	2.1059-01
9	4.4566+04	1.2219+03	8.8972-01	5.0089+04	1.4200-01	2.0376-01
10	4.8828+04	1.1671+03	1.2528+00	3.8974+04	1.0949-01	2.9521-01
11	4.8964+04	1.1671+03	1.1884+00	4.1203+04	1.1575-01	3.0057-01
12	4.9162+04	1.1670+03	1.2640+00	3.8894+04	1.0927-01	2.9785-01
13	6.2536+04	1.1672+03	1.3081+00	4.7806+04	1.3452-01	4.1776-01
14	6.2165+04	1.1674+03	1.3788+00	4.5087+04	1.2687-01	4.2615-01
15	6.2442+04	1.1672+03	1.3631+00	4.5808+04	1.2890-01	4.1166-01
16	5.7739+04	1.1163+03	2.5361+00	2.2767+04	6.3680-02	4.5334-01
17	5.7822+04	1.1162+03	2.6102+00	2.2153+04	6.1963-02	4.6165-01
18	5.8091+04	1.1161+03	2.3543+00	2.4675+04	6.9015-02	4.4361-01
19	3.3205+04	1.1201+03	1.3362+00	2.4851+04	6.9414-02	1.9984-01
20	3.3478+04	1.1200+03	1.3580+00	2.4652+04	6.8860-02	2.0285-01
21	3.3286+04	1.1202+03	1.2377+00	2.6893+04	7.5118-02	2.0989-01
22	6.3109+04	1.1457+03	1.9003+00	3.3210+04	9.3189-02	4.7113-01
23	6.2975+04	1.1458+03	2.0339+00	3.0963+04	8.6884-02	4.7979-01
24	6.3356+04	1.1457+03	1.8802+00	3.3696+04	9.4553-02	4.8054-01
25	9.9780+04	1.1723+03	2.6412+00	3.7779+04	1.0688-01	8.2570-01
26	1.0001+05	1.1725+03	2.4978+00	4.0039+04	1.1328-01	8.3550-01
27	9.9767+04	1.1727+03	2.7845+00	3.5829+04	1.0138-01	8.1969-01
28	1.7457+05	1.1809+03	5.4466+00	3.2050+04	9.1634-02	1.9186+00
29	1.7485+05	1.1807+03	5.3169+00	3.2887+04	9.4024-02	1.9158+00
30	1.7416+05	1.1809+03	5.3887+00	3.2319+04	9.2400-02	1.8500+00

CONDENSING DATA REDUCTION

	451	452	453	610	611	613
	PI	PO	DPC	PIC	POC	DPCC
1	8.7287+00	8.7954+00	-6.6634-02	8.7639+00	8.8167+00	-5.2808-02
2	8.7160+00	8.7858+00	-6.9807-02	8.7501+00	8.8072+00	-5.7074-02
3	8.7076+00	8.7890+00	-8.1442-02	8.7424+00	8.8103+00	-6.7995-02
4	6.8576+00	7.0651+00	-2.0744-01	6.9148+00	7.0756+00	-1.6076-01
5	6.8559+00	7.0531+00	-1.9724-01	6.9130+00	7.0636+00	-1.5062-01
6	6.8594+00	7.0605+00	-2.0109-01	6.9164+00	7.0710+00	-1.5454-01
7	6.5502+00	6.6607+00	-1.1051-01	6.5793+00	6.6687+00	-8.9438-02
8	6.5518+00	6.6528+00	-1.0096-01	6.5815+00	6.6608+00	-7.9277-02
9	6.5468+00	6.6493+00	-1.0246-01	6.5752+00	6.6573+00	-8.2086-02
10	4.6850+00	4.8418+00	-1.5683-01	4.7264+00	4.8399+00	-1.1345-01
11	4.6837+00	4.8425+00	-1.5881-01	4.7260+00	4.8406+00	-1.1459-01
12	4.6850+00	4.8431+00	-1.5820-01	4.7269+00	4.8413+00	-1.1441-01
13	4.9106+00	5.1422+00	-2.3161-01	4.9724+00	5.1418+00	-1.6934-01
14	4.9065+00	5.1450+00	-2.3856-01	4.9697+00	5.1446+00	-1.7491-01
15	4.9119+00	5.1422+00	-2.3025-01	4.9728+00	5.1418+00	-1.6898-01
16	3.4275+00	3.6528+00	-2.2532-01	3.4945+00	3.6461+00	-1.5163-01
17	3.4284+00	3.6538+00	-2.2539-01	3.4969+00	3.6472+00	-1.5029-01
18	3.4275+00	3.6465+00	-2.1908-01	3.4929+00	3.6399+00	-1.4696-01
19	3.2394+00	3.2993+00	-5.9937-02	3.2663+00	3.2913+00	-2.5070-02
20	3.2462+00	3.3008+00	-5.4576-02	3.2735+00	3.2928+00	-1.9308-02
21	3.2442+00	3.3003+00	-5.6038-02	3.2726+00	3.2923+00	-1.9694-02
22	4.2890+00	4.5111+00	-2.2212-01	4.3598+00	4.5077+00	-1.4790-01
23	4.2951+00	4.5144+00	-2.1923-01	4.3673+00	4.5110+00	-1.4367-01
24	4.2976+00	4.5157+00	-2.1807-01	4.3698+00	4.5123+00	-1.4242-01
25	5.8624+00	6.2418+00	-3.7935-01	5.9965+00	6.2473+00	-2.5088-01
26	5.8592+00	6.2543+00	-3.9503-01	5.9951+00	6.2599+00	-2.6482-01
27	5.8941+00	6.2626+00	-3.6846-01	6.0265+00	6.2683+00	-2.4174-01
28	8.2561+00	8.8783+00	-6.2218-01	8.5978+00	8.9011+00	-3.0337-01
29	8.2682+00	8.8661+00	-5.9788-01	8.6095+00	8.8889+00	-2.7941-01
30	8.2521+00	8.8661+00	-6.1404-01	8.5801+00	8.8889+00	-3.0877-01

CONDENSING DATA REDUCTION

	700	495	701	498	504	507
	X B	WKL B	X T	WKL T	NREF T	NREF B
1	2.4941-01	1.3706+01	8.0362-01	3.5860+00	4.3412+02	1.6597+03
2	2.4964-01	1.3480+01	8.0383-01	3.5239+00	4.2655+02	1.6322+03
3	2.5108-01	1.3573+01	8.0516-01	3.5313+00	4.2742+02	1.6435+03
4	2.6211-01	1.5160+01	8.1528-01	3.7949+00	4.4947+02	1.7977+03
5	2.6106-01	1.5164+01	8.1432-01	3.8104+00	4.5127+02	1.7980+03
6	2.6140-01	1.5157+01	8.1463-01	3.8041+00	4.5056+02	1.7973+03
7	2.5824-01	1.0906+01	8.1178-01	2.7673+00	3.2614+02	1.2862+03
8	2.5655-01	1.1014+01	8.1022-01	2.8116+00	3.3135+02	1.2989+03
9	2.5679-01	1.0826+01	8.1046-01	2.7609+00	3.2535+02	1.2766+03
10	2.6824-01	1.1013+01	8.2092-01	2.6951+00	3.0783+02	1.2595+03
11	2.6861-01	1.1106+01	8.2124-01	2.7144+00	3.1004+02	1.2702+03
12	2.6836-01	1.1060+01	8.2103-01	2.7055+00	3.0903+02	1.2650+03
13	2.7244-01	1.3335+01	8.2471-01	3.2128+00	3.6887+02	1.5339+03
14	2.7386-01	1.3438+01	8.2597-01	3.2207+00	3.6977+02	1.5458+03
15	2.7222-01	1.3242+01	8.2453-01	3.1926+00	3.6656+02	1.5231+03
16	2.8076-01	1.1664+01	8.3235-01	2.7188+00	3.0233+02	1.3001+03
17	2.8020-01	1.1783+01	8.3182-01	2.7531+00	3.0615+02	1.3134+03
18	2.7914-01	1.1562+01	8.3090-01	2.7121+00	3.0155+02	1.2885+03
19	2.5020-01	7.8245+00	8.0445-01	2.0407+00	2.2524+02	8.6399+02
20	2.4776-01	7.9170+00	8.0218-01	2.0820+00	2.2984+02	8.7427+02
21	2.4849-01	8.0445+00	8.0284-01	2.1105+00	2.3298+02	8.8833+02
22	2.6962-01	1.3377+01	8.2223-01	3.2558+00	3.6907+02	1.5191+03
23	2.6857-01	1.3529+01	8.2127-01	3.3059+00	3.7481+02	1.5366+03
24	2.6814-01	1.3552+01	8.2088-01	3.3166+00	3.7605+02	1.5391+03
25	2.6418-01	2.0676+01	8.1725-01	5.1352+00	6.0029+02	2.4221+03
26	2.6571-01	2.0753+01	8.1863-01	5.1259+00	5.9922+02	2.4314+03
27	2.6294-01	2.0683+01	8.1612-01	5.1600+00	6.0345+02	2.4238+03
28	2.5424-01	3.7736+01	8.0807-01	9.7119+00	1.1744+03	4.5710+03
29	2.5335-01	3.7778+01	8.0725-01	9.7527+00	1.1794+03	4.5758+03
30	2.5409-01	3.7027+01	8.0795-01	9.5336+00	1.1526+03	4.4845+03

APPENDIX E

ANALYSIS OF SOME OF THE ERRORS
ASSOCIATED WITH THE MEASUREMENT OF
TEMPERATURE DIFFERENCES
IN THE 100 KW LOOP

G. L. Converse

APPENDIX E

Analysis of Some of the Errors Associated with the Measurement of Temperature Differences in the 100 KW Loop

There are several sources of error in the determination of the inside wall to fluid temperature difference in the 100 KW loop. The more important sources of error are the following:

1. Random errors in the measurement of outside wall and fluid temperatures.

2. Errors due to thermocouple drift.

3. Errors in the calculation of inside wall temperature due to the uncertainty in wall thermal conductivity.

4. Errors in the calculation of inside wall temperature caused by uncertainty in the heat flux.

Additional sources of error such as that due to uncertainty in the tube wall thickness are probably less important and were not considered.

Since, in general, two measurements of outside wall temperature are made at the exit of the tube while only a single outside wall temperature measurement is made at each station in the remainder of the tube, it was necessary to consider two cases. The calculational procedure together with a summary of the calculations will be given for each case.

Case I   <u>Measuring Station not at the Tube Exit</u>   (One
outside wall thermocouple at the measuring station,
and three well thermocouples located at the tube
exit)

1. (a)   Random error in the measurement of outside wall
temperature.

This error was calculated from multiple digital
readouts of the outside wall temperature at a
given station. These calculations are summarized
in the table below.

TABLE (1)

<u>RANDOM ERROR IN A SINGLE OUTSIDE WALL THERMOCOUPLE</u>

<u>NOT AT THE TUBE EXIT</u>

I.D. Date-Time-Run	X mv	Avg.X, $\overline{X}$ mv	$\delta X,$ $X - \overline{X}$ mv	$(\delta X)^2$ $(mv)^2$	Probable Error of Each Case= $P_{1,2,3}$
8274-1620-1 8274-1620-2 8274-1620-3	14.681 14.682 14.698	14.687	-.006 -.005 .011	3.6×10^{-5} 2.5×10^{-5} 12.1×10^{-5}	.00643 .00643 .00643
8274-2222-1 8274-2222-2 8274-2222-3	14.386 14.399 14.416	14.400	-.014 -.001 .016	19.6×10^{-5} 0.1×10^{-5} 25.6×10^{-5}	.01015 .01015 .01015
8284-0238-1 8284-0238-2 8284-0238-3	14.369 14.345 14.351	14.355	.014 -.010 -.004	19.6×10^{-5} 10.0×10^{-5} 1.6×10^{-5}	.00842 .00842 .00842

$$K = \Sigma \text{ no. occurrences} = 3$$

$$\Sigma(\delta X)^2 = 18.2 \times 10^{-5}, \ 45.3 \times 10^{-5}, \ 31.2 \times 10^{-5}$$

Probable error of each case: $p_i = .6745 \sqrt{\dfrac{\Sigma(\delta X)^2}{K-1}}$

Probable error: $P = \displaystyle\sum_{i=1}^{3} p_i/3 = .0083368$ mv

$\therefore p = 0.835^\circ F$ (random error)

1. (b) Random error in the measurement of the fluid
        temperature

Next the random errors in each of the three exit
well thermocouples are calculated. Since the
arithmetic average of the three exit well readings
is used in the calculation of the wall to fluid
temperature difference, the probable errors were
combined to obtain the probable error in the
average. In general, for independent error,

if z = $f(x,y)$

then

$$P(z) = \sqrt{\left[P(x)\ \frac{\partial z}{\partial x}\right]^2 + \left[P(y)\ \frac{\partial z}{\partial y}\right]^2} \quad (1)$$

Since

$$T_{f\text{-avg}} = (T_{f\text{-}1} + T_{f\text{-}2} + T_{f\text{-}3})/3$$

then

$$P(T_{f\text{-avg}}) = \frac{1}{3}\sqrt{\left[P(T_{f\text{-}1})\right]^2 + \left[P(T_{f\text{-}2})\right]^2 + \left[P(T_{f\text{-}3})\right]^2}$$

This calculation is summarized in Table (2).

TABLE (2)

THE RANDOM ERROR OF THREE (3) EXIT WELL THERMOCOUPLES IN THE 100 KW LOOP

I.D. Date-Time-Run	X_1 mv	X_2 mv	X_3 mv	δX_1 mv	δX_2 mv	δX_3 mv	$(\delta X_1)^2$ mv²	$(\delta X_2)^2$ mv²	$(\delta X_3)^2$ mv²
8274-1620-1	14.551	14.669	14.622	.003	.002	.006	0.9×10^{-5}	0.4×10^{-5}	3.6×10^{-5}
8274-1620-2	14.547	14.666	14.618	-.001	-.001	.002	0.1×10^{-5}	0.1×10^{-5}	0.4×10^{-5}
8274-1620-3	14.546	14.665	14.607	-.002	-.002	-.009	0.4×10^{-5}	0.4×10^{-5}	8.1×10^{-5}
8274-2222-1	14.246	14.403	14.346	.004	.001	.011	1.6×10^{-5}	0.1×10^{-5}	12.1×10^{-5}
8274-2222-2	14.248	14.405	14.337	.006	.003	.002	3.6×10^{-5}	0.9×10^{-5}	0.4×10^{-5}
8274-2222-3	14.233	14.397	14.322	-.009	-.005	-.013	8.1×10^{-5}	2.5×10^{-5}	16.9×10^{-5}
8284-0238-1	14.218	14.369	14.311	.010	.002	.015	10.0×10^{-5}	0.4×10^{-5}	22.5×10^{-5}
8284-0238-2	14.201	14.365	14.287	-.007	-.002	-.009	4.9×10^{-5}	0.4×10^{-5}	8.1×10^{-5}
8284-0238-3	14.205	14.366	14.290	-.003	-.001	-.006	0.9×10^{-5}	0.1×10^{-5}	3.6×10^{-5}

$K_1 = K_2 = K_3 = $ no. occurrences $= 3$

Average: (8274-1620) $\bar{X}_1 = 14.548$, $\bar{X}_2 = 14.667$, $\bar{X}_3 = 14.616$

(8274-2222) $\bar{X}_1 = 14.242$, $\bar{X}_2 = 14.402$, $\bar{X}_3 = 14.335$

(8284-0238) $\bar{X}_1 = 14.208$, $\bar{X}_2 = 14.367$, $\bar{X}_3 = 14.296$

$\Sigma(\delta X_1)^2 = 1.4 \times 10^{-5}$ mv, 13.3×10^{-5} mv, 15.8×10^{-5} mv

$\Sigma(\delta X_2)^2 = 0.9 \times 10^{-5}$ mv, 3.5×10^{-5} mv, 0.9×10^{-5} mv

$\Sigma(\delta X_3)^2 = 12.1 \times 10^{-5}$ mv, 29.4×10^{-5} mv, 34.2×10^{-5} mv

TABLE (2) (Continued)

THE RANDOM ERROR OF THREE (3) EXIT WELL THERMOCOUPLES IN THE 100 KW LOOP

Probable error (each group):

$$p_1 = .001785 \text{ mv}, \quad .005500 \text{ mv}, \quad .005995 \text{ mv}$$

$$p_2 = .0014308 \text{ mv}, \quad .0028216 \text{ mv}, \quad .0014308 \text{ mv}$$

$$p_3 = .0052464 \text{ mv}, \quad .0081779 \text{ mv}, \quad .0088202 \text{ mv}$$

Probable error (each couple):

$$P_1 = \frac{1}{3} \sum_{i=1}^{3} p_{1_i}/3 = .004427 \text{ mv} \longrightarrow .444 \text{ }^{\circ}\text{F}$$

$$P_2 = \frac{1}{3} \sum_{i=1}^{3} p_{2_i}/3 = .0018944 \text{ mv} \longrightarrow .190 \text{ }^{\circ}\text{F}$$

$$P_3 = \frac{1}{3} \sum_{i=1}^{3} p_{3_i}/3 = .007415 \text{ mv} \longrightarrow .743 \text{ }^{\circ}\text{F}$$

Probable error (all 3 couples):

$$P* = \frac{1}{3} \sqrt{P_1^2 + P_2^2 + P_3^2} = .002947 \text{ mv} = 0.295 \text{ }^{\circ}\text{F} \text{ (random error)}$$

Random error in the outside wall to fluid temperature difference (1 wall and 3 well thermocouples):

$$P_{RN} = \sqrt{(p)^2 + (P*)^2} = \pm .886 \text{ }^{\circ}\text{F}$$

These two errors (i.e., 1.(a) and 1.(b) above) have
been combined in accordance with equation 1 above to
obtain the random error in the outside wall to fluid
temperature difference.

2.   Errors due to thermocouple drift

The general procedure in calibrating the thermocouples
in the 100 KW loop is to calibrate all thermocouples
relative to a single well thermocouple (designated as
B-5 and taken as the standard) both before and after
testing. Since these relative calibrations are not
in general the same, some thermocouple drift with time
is implied. The average of these two calibrations is
then used to correct the individual couple readings.
Strictly speaking, this is not a random error and
should be treated separately for each thermocouple in
the analysis (as it is in making the thermocouple cor-
rections). However, since this procedure would result
in a different error curve for each thermocouple, in
order to facilitate the analysis the thermocouple drift
will be treated as a random error and thus independent
of the particular thermocouple. It will then be treated
as an independent error in the outside wall to fluid
temperature difference and combined in accordance with
equation 1 with the random error calculated above.
This calculation is summarized in Table (3).

TABLE (3)

ERRORS DUE TO THERMOCOUPLE DRIFT (TREATED AS RANDOM ERRORS)

Thermocouple Number	Run 1 Before Test X_1 °F	Run 2 Before Test X_2 °F	Run 3 After Test X_3 °F	Run 4 After Test X_4 °F	$\bar{X}_1 = \dfrac{X_1+X_2}{2}$ °F	$\bar{X}_2 = \dfrac{X_3+X_4}{2}$ °F	$6X = \dfrac{\|X_1-X_2\|}{2}$ °F	$(6X)^2$ $(°F)^2$
A20	4.45	3.66	9.38	5.45	4.055	7.415	1.680	2.8224
A21	2.04	2.50	1.06	3.10	2.27	2.08	.095	.009025
A22	-0.66	-0.049	-1.50	-0.28	-0.3545	-0.89	.26775	.07169
A23	0.17	0.58	-0.96	-1.37	0.375	-1.165	.77000	.5929
A24	4.61	2.94	2.45	2.80	3.775	2.625	.0575	.003306
A25	3.65	3.71	2.11	3.71	3.68	2.91	.385	.148225
B1	6.61	6.91	6.10	6.48	6.76	6.29	.235	.055225
B2	4.50	3.50	5.76	4.62	4.00	5.19	.595	.354025
B3	-0.31	-0.44	-0.24	-0.25	-0.375	-0.245	.065	.004225
B4	-6.29	-6.58	-6.26	-6.34	-6.435	-6.30	.0675	.004556

K = no. occurrences = 10

$\Sigma(6X)^2 = 4.065577$

Probable error:

$P_{DRIFT} = .6745 \sqrt{\dfrac{\Sigma(6X)^2}{K-1}} = .45334 \,°_F$

Case II Measuring Station at the Tube Exit (Two Outside
Wall Thermocouples and Three Exit Well Thermo-
couples)

These calculations are identical to those in
Case I with the exception that the
arithmetic average of two outside wall thermo-
couples is used in obtaining the outside wall
temperature. The calculation of the probable
random error in the average of these two couples
is given in Table (4).

This error is combined with the previously cal-
culated well thermocouple (fluid temperature)
error, in accordance with equation 1 above, to
obtain the random error in the outside wall to
fluid temperature difference at the end of the
heated length.

TABLE (4)

RANDOM ERROR IN THE AVERAGE OF TWO
OUTSIDE WALL THERMOCOUPLES

I.D. Date-Time-Run	X_1 mv	X_2 mv	δX_1 mv	δX_2 mv	$(\delta X_1)^2$ $(mv)^2$	$(\delta X_2)^2$ $(mv)^2$
8274-1620-1	14.770	14.776	.003	.011	0.9×10^{-5}	12.1×10^{-5}
8274-1620-2	14.765	14.765	-.002	.000	0.4×10^{-5}	0
8274-1620-3	14.766	14.753	-.001	-.012	0.1×10^{-5}	14.4×10^{-5}
8274-2222-1	14.447	14.442	.003	.001	0.9×10^{-5}	0.1×10^{-5}
8274-2222-2	14.446	14.434	.002	-.007	0.4×10^{-5}	4.9×10^{-5}
8274-2222-3	14.440	14.448	-.004	.007	1.6×10^{-5}	4.9×10^{-5}
8284-0238-1	14.413	14.412	.010	.011	10.0×10^{-5}	12.1×10^{-5}
8284-0238-2	14.404	14.403	.001	.002	0.1×10^{-5}	0.4×10^{-5}
8284-0238-3	14.393	14.388	-.010	-.013	10.0×10^{-5}	16.9×10^{-5}

$$K_1 = K_2 = \Sigma \text{no. occurrences} = 3$$

Average: (8274-1620) $\overline{X}_1 = 14.767$, $\overline{X}_2 = 14.765$

(8274-2222) $\overline{X}_1 = 14.444$, $\overline{X}_2 = 14.441$

(8284-0238) $\overline{X}_1 = 14.403$, $\overline{X}_2 = 14.401$

$$\Sigma(\delta X_1)^2 = 1.4 \times 10^{-5}, \quad 2.9 \times 10^{-5}, \quad 20.1 \times 10^{-5}$$
$$\Sigma(\delta X_2)^2 = 26.5 \times 10^{-5}, \quad 9.9 \times 10^{-5}, \quad 29.4 \times 10^{-5}$$

Probable error (each group):

$$p_i = .001785 \text{ mv}, \quad .002568 \text{ mv}, \quad .006762 \text{ mv}$$
$$p_j = .0077635 \text{ mv}, \quad .006711 \text{ mv}, \quad .0081776 \text{ mv}$$

Average error (each couple):

$$p' = \sum_{i=1}^{3} p_i/3 = .003705 \text{ mv}$$
$$p'' = \sum_{j=1}^{3} p_j/3 = .0075507 \text{ mv}$$

TABLE (4)   (Continued)

Probable error (both couples):
$$P_1 = \tfrac{1}{2} \sqrt{(p')^2 + (p'')^2} \quad = .0084108/2 \quad = .0042054 \text{ mv.}$$

$$P_1 = .421 {}^\circ F \text{ (random error)}$$

Random error in the calculation of the outside wall to fluid
temperature difference at the test section exit:
$$P_{RX} = \sqrt{(P_1)^2 + (P*)^2} \quad = \pm .516 {}^\circ F$$

Conclusion: Errors due to uncertainty in the thermal
              conductivity of the wall and the heat flux

These two errors can be conveniently treated together in the
following manner.
$$T_{wi} - T_f = (T_{wo} - T_f) - q'' \left(\frac{D_o \, \ell n \, (D_o/D_i)}{2k} \right) \tag{2}$$
From equations 1 and 2,
$$P(T_{w_i} - T_f) = \sqrt{ P(T_{w_o} - T_f)^2 + \left[q'' \, \frac{D_o \, \ell n \, (D_o/D_i)}{2k} \right]^2 \left[\left(\frac{P(q'')}{q''} \right)^2 + \left(\frac{P(k)}{k} \right)^2 \right] } \tag{3}$$
The probable percentage error in wall thermal conductivity is
estimated as $\pm 4\%$ based on the results obtained in Reference 12.
The estimated probable percentage error in heat flux is $\pm 3\%$.

Then $\left(\frac{P(q'')}{q''} \right)^2 + \left(\frac{P(k)}{k} \right)^2 = (.04)^2 + (.03)^2 = (.05)^2$

$$P(T_{w_i} - T_f) = \sqrt{ P(T_{w_o} - T_f)^2 + (.05)^2 \left[\frac{q'' \, D_o \, \ell n \, (D_o/D_i)}{2k} \right]^2 } \tag{4}$$

The probable error in the inside wall to fluid temperature differ-
ence is calculated from equation 4. A summary of the calculation
is given in the table following.

TABLE (5)

ERROR IN INSIDE WALL TO FLUID TEMPERATURE DIFFERENCE

① Random error (1-non-exit couple) $0.886^{\circ}F$

② Random error (2-exit couples) $0.516^{\circ}F$

③ Calibration error $0.45334^{\circ}F$

④ ③^2 $0.205517 \ (^{\circ}F)^2$

⑤ ①^2 + ④ $P_{T_{W_o}}^2$ (1 cpl.) $0.99051 \ (^{\circ}F)^2$

⑥ ②^2 + ④ $P_{T_{W_o}}^2$ (2 cpls.) $0.47177 \ (^{\circ}F)^2$

⑦ Random error (in well cpls.) $P_{T_{sat}}$ $0.295^{\circ}F$

⑧ ⑦^2 $0.087025 \ (^{\circ}F)^2$

⑨ ⑤ + ⑧ $(P_{T_{W_o}-T_f})^2$ (1 cpl.) $1.077535 \ (^{\circ}F)^2$

⑩ ⑥ + ⑧ $(P_{T_{W_o}-T_f})^2$ (2 cpls.) $.558795 \ (^{\circ}F)^2$

Thermal conductivity of Cb-1Zr:

$$k = 32 \ Btu/hr\text{-}ft\text{-}^{\circ}F \text{ at } 1800^{\circ}F$$

For a 3/4-inch nominal tube diameter

$$\ell n\left(D_o/D_i\right) = .31306; \quad D_o = .08741667 \text{ ft}$$

$$\text{Let } F = \left[\frac{D_o \ell n\left(D_o/D_i\right)}{2k}\right]^2 = 4.57113 \times 10^{-10} \left(\frac{^{\circ}F}{Btu/hr\text{-}ft^2}\right)^2$$

TABLE (5) (Continued)
ERROR IN INSIDE WALL TO FLUID TEMPERATURE DIFFERENCE

⑪ q'' $\dfrac{Btu}{hr\text{-}ft^2}$	⑫ $F \times (q'')^2$	⑬ ⑨ + ⑫	⑭ ⑩ + ⑫	⑮ $\sqrt{⑬}$ $(PT_{wi}-T_f)_1$	⑯ $\sqrt{⑭}$ $(PT_{wi}-T_f)_2$
0	0	1.077535	0.558795	$1.038^{\circ}F$	$0.74753^{\circ}F$
2.5×10^4	0.2857	1.3632	0.8445	$1.1676^{\circ}F$	$0.91897^{\circ}F$
5.0×10^4	1.1428	2.2203	1.7016	$1.4900^{\circ}F$	$1.30450^{\circ}F$
7.5×10^4	2.5713	3.6488	3.1301	$1.9102^{\circ}F$	$1.7692^{\circ}F$
1.0×10^5	4.5711	5.6486	5.1299	$2.3767^{\circ}F$	$2.2649^{\circ}F$
1.25×10^5	7.1424	8.2199	7.7012	$2.8671^{\circ}F$	$2.7751^{\circ}F$
1.5×10^5	10.2850	11.363	10.844	$3.3709^{\circ}F$	$3.2930^{\circ}F$

Although the above analysis is somewhat lacking in statistical rigor, it is felt that it may provide a somewhat better estimation of the error in the measurement of the inside wall to fluid temperature difference than can be obtained from an educated guess based on operating experience.

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